Air Traffic Control Seminar

Current ATC Operations: Terminal Radar Approach Control

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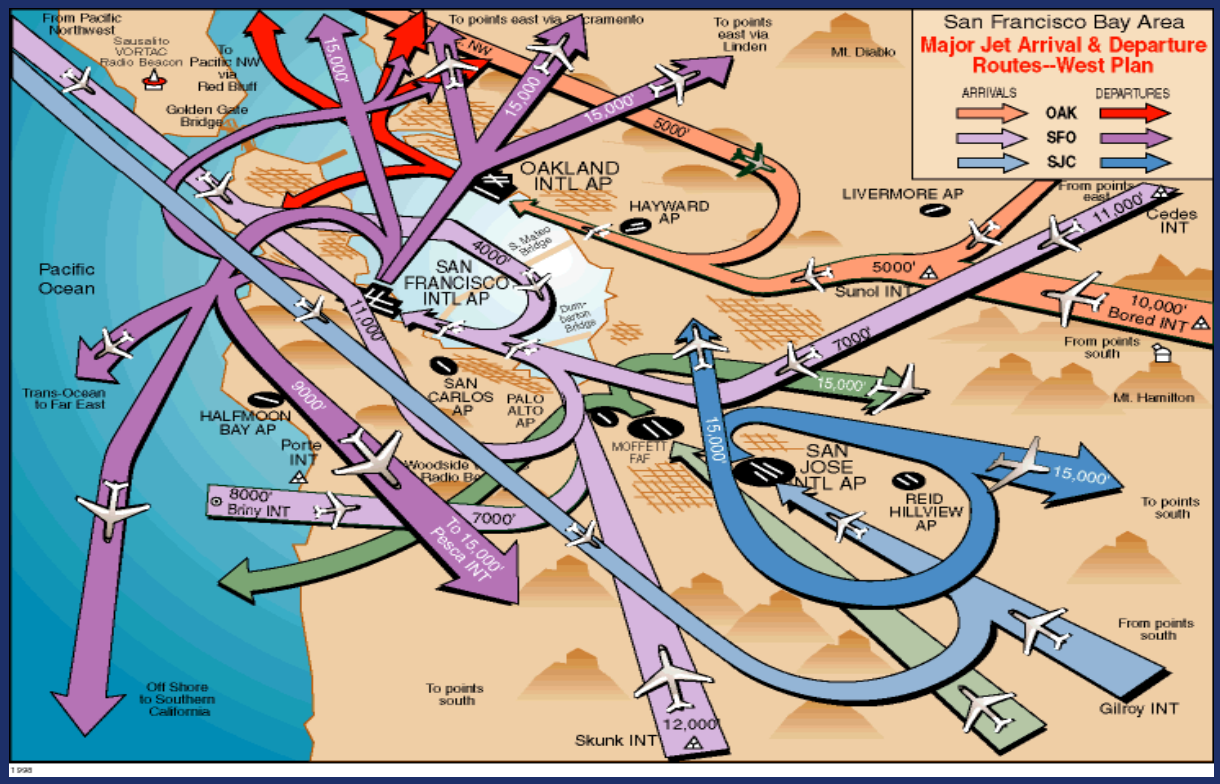
Northern California TRACON

NASA Ames Research Center

Moffett Field, California

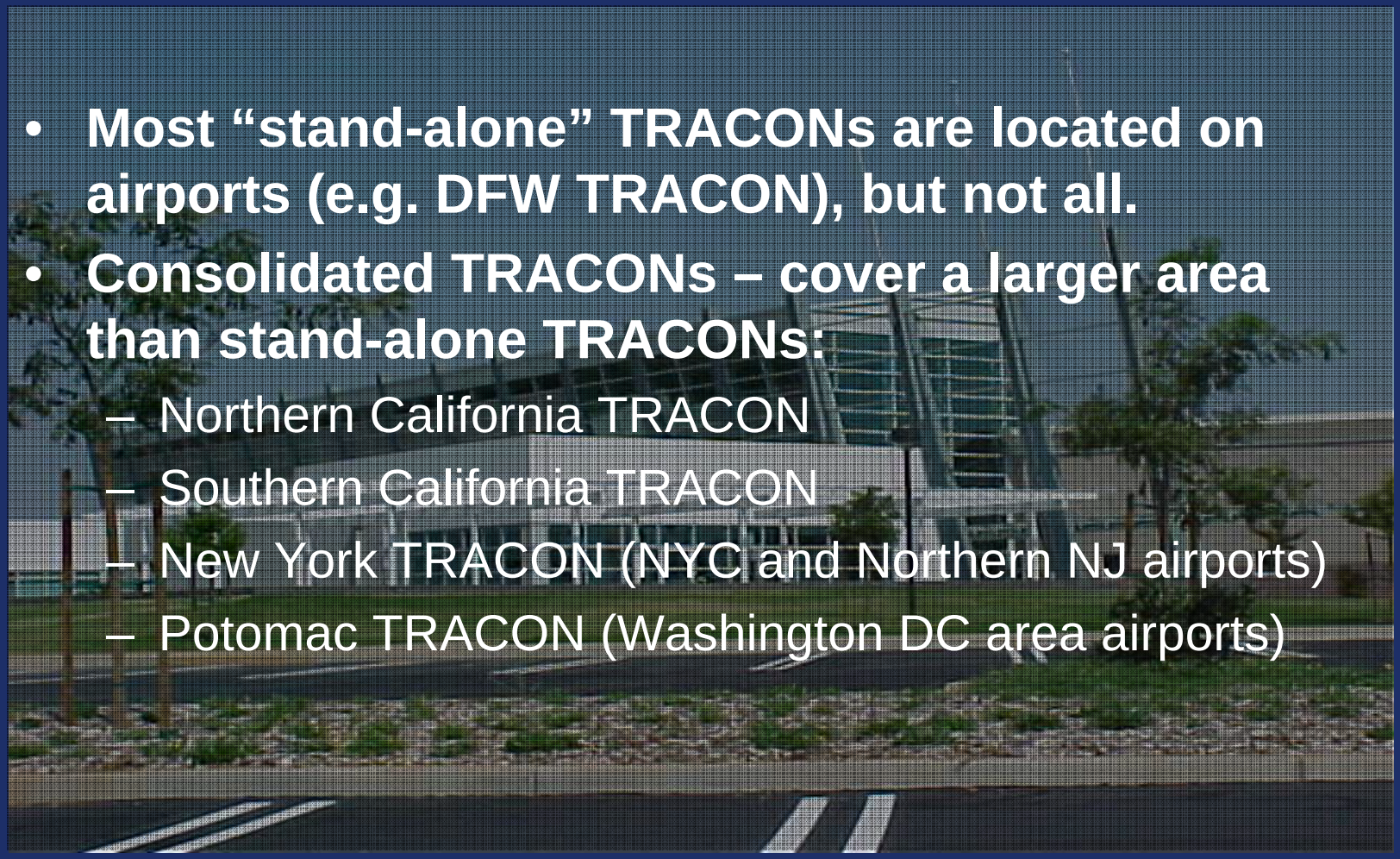
September 5-6, 2007

Terminal Radar Approach Control (TRACON)

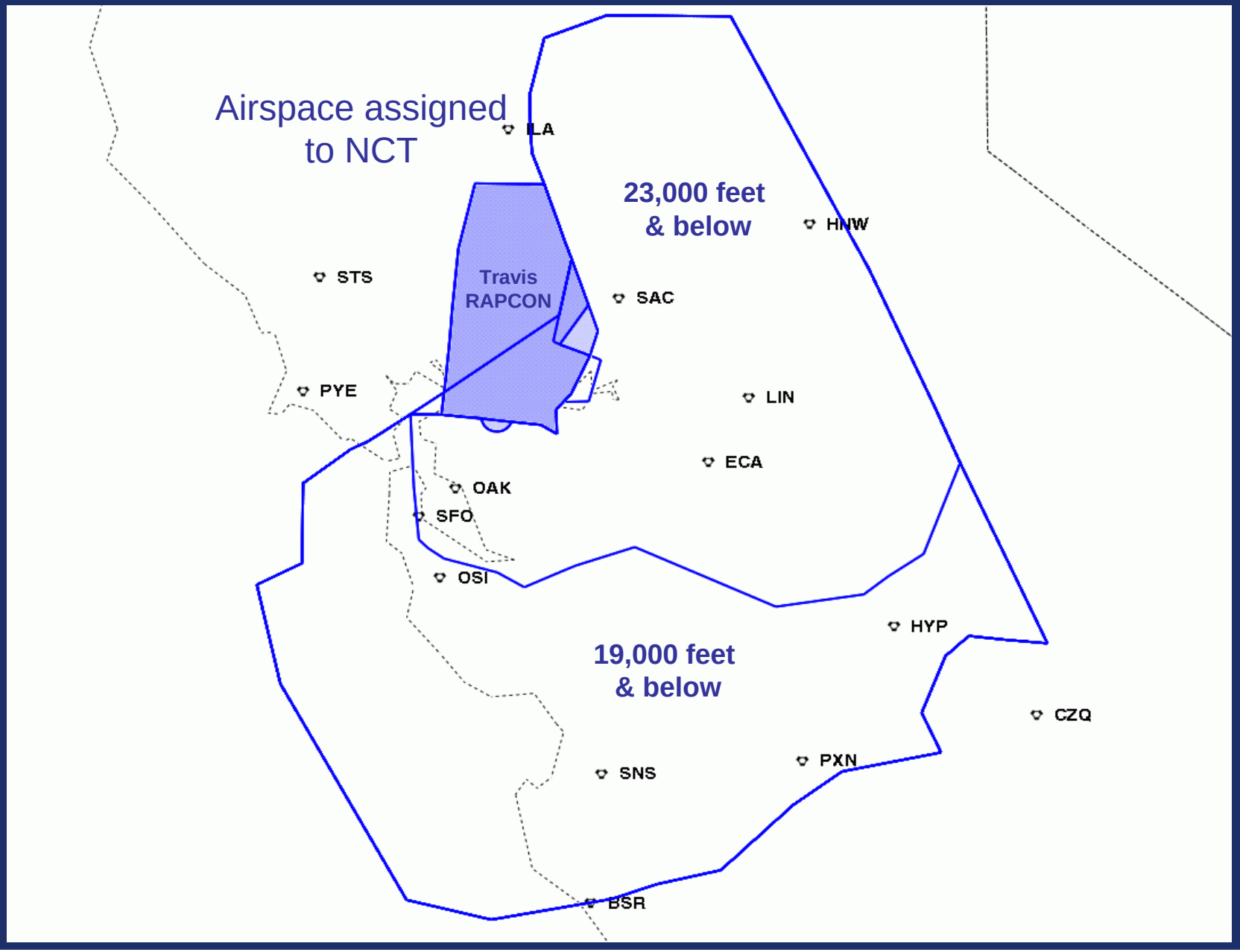


The TRACON's main function is to separate arrivals from departures to and from the underlying airports (towered and non-towered)

TRACONs



- **Most "stand-alone" TRACONs are located on airports (e.g. DFW TRACON), but not all.**
- **Consolidated TRACONs – cover a larger area than stand-alone TRACONs:**
  - Northern California TRACON
  - Southern California TRACON
  - New York TRACON (NYC and Northern NJ airports)
  - Potomac TRACON (Washington DC area airports)


Airspace assigned to NCT
ILA
23,000 feet & below
HNW
STS
Travis RAPCON
SAC
PYE
LIN
ECA
OAK
SFO
OSI
HYP
19,000 feet & below
CZQ
PXN
SNS
BSR

Departure Procedures (DP):

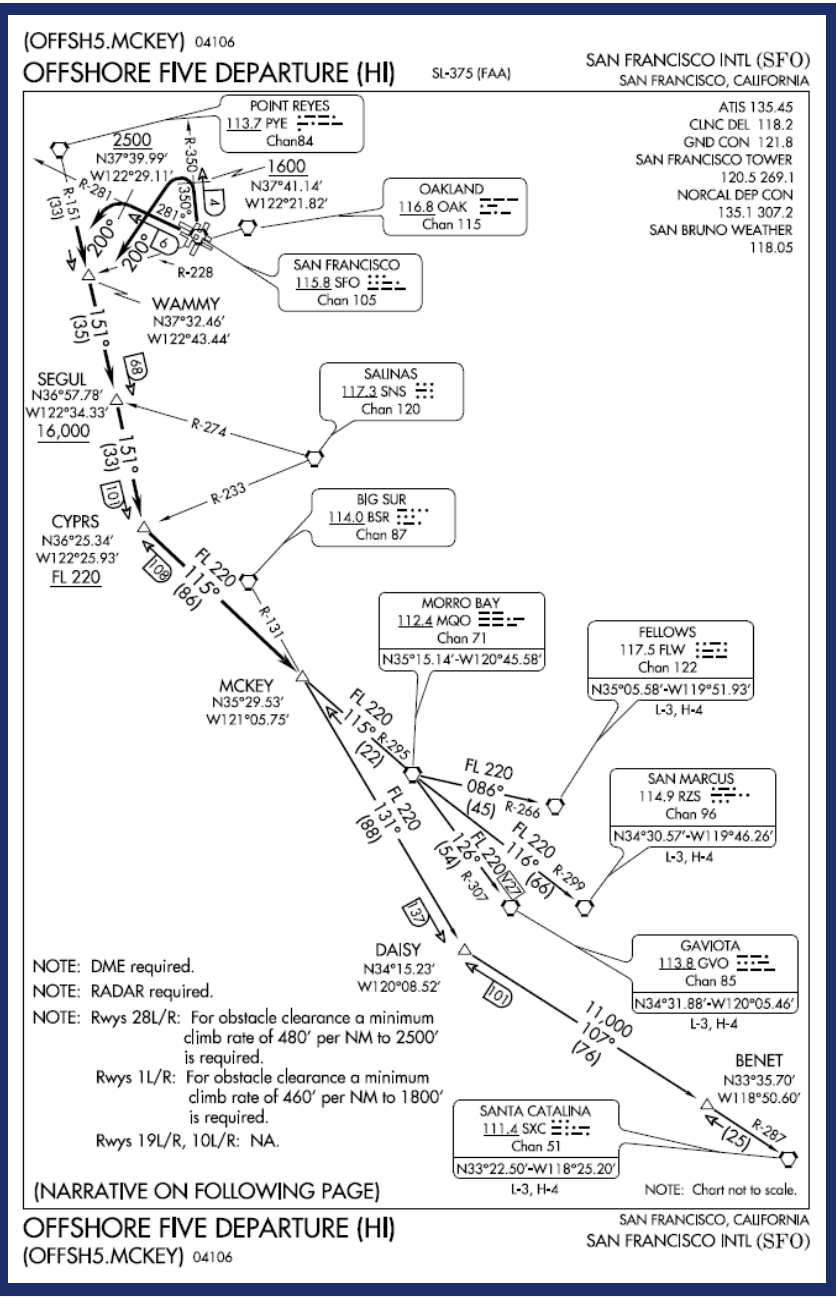
- Most departures in a busy environment will be assigned a DP.
- DP's provide for obstacle and terrain clearance (a climb of 200 feet per NM is assumed).
- DP's can be textual or graphical.

SACRAMENTO MATHER

DEPARTURE PROCEDURE: **Rwys 4L,4R**, climbing right turn direct SAC VORTAC. **Rwys 22 L,22R** climb direct SAC VORTAC.

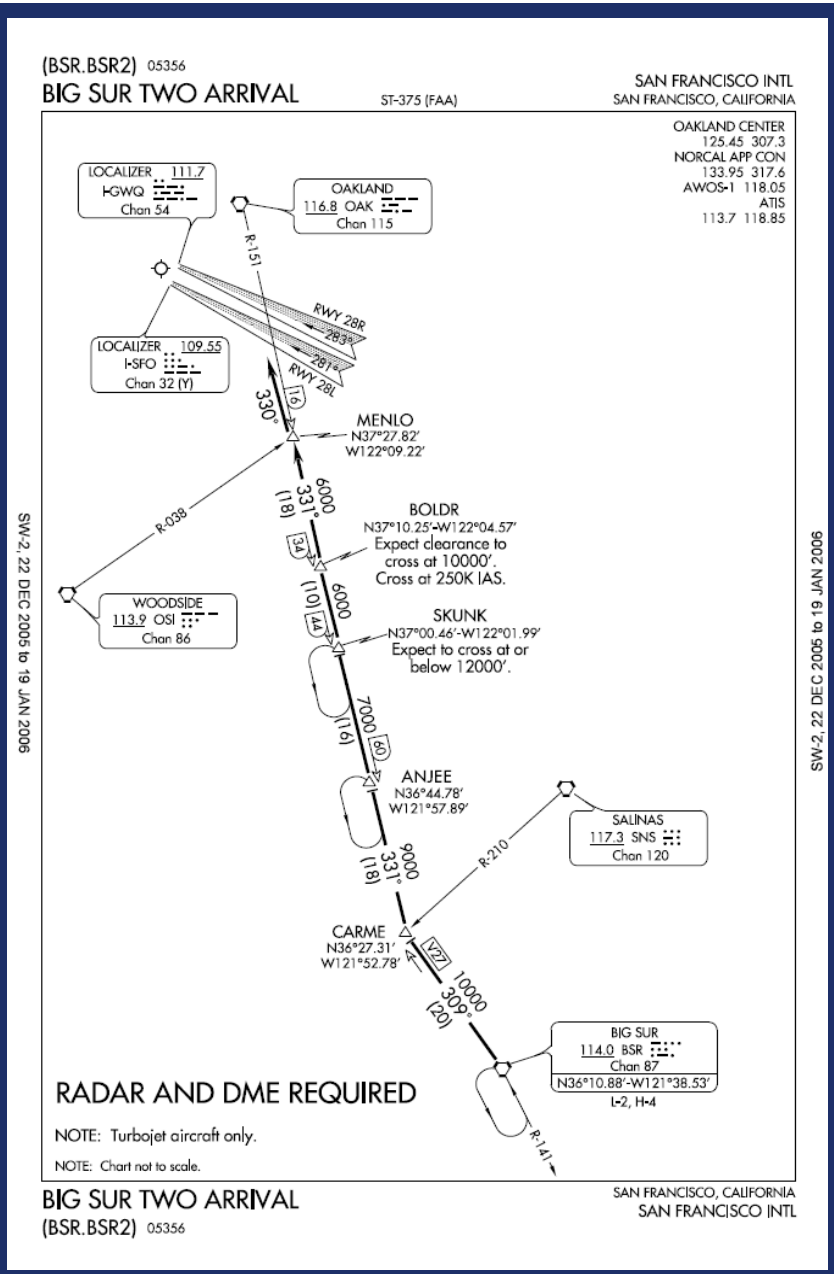
Standard Instrument Departure (SID):

- A SID is a DP built for ATC needs.
- SID's provide for obstacle and terrain clearance (a climb of 200 feet per NM is assumed).
- SID's are graphical.



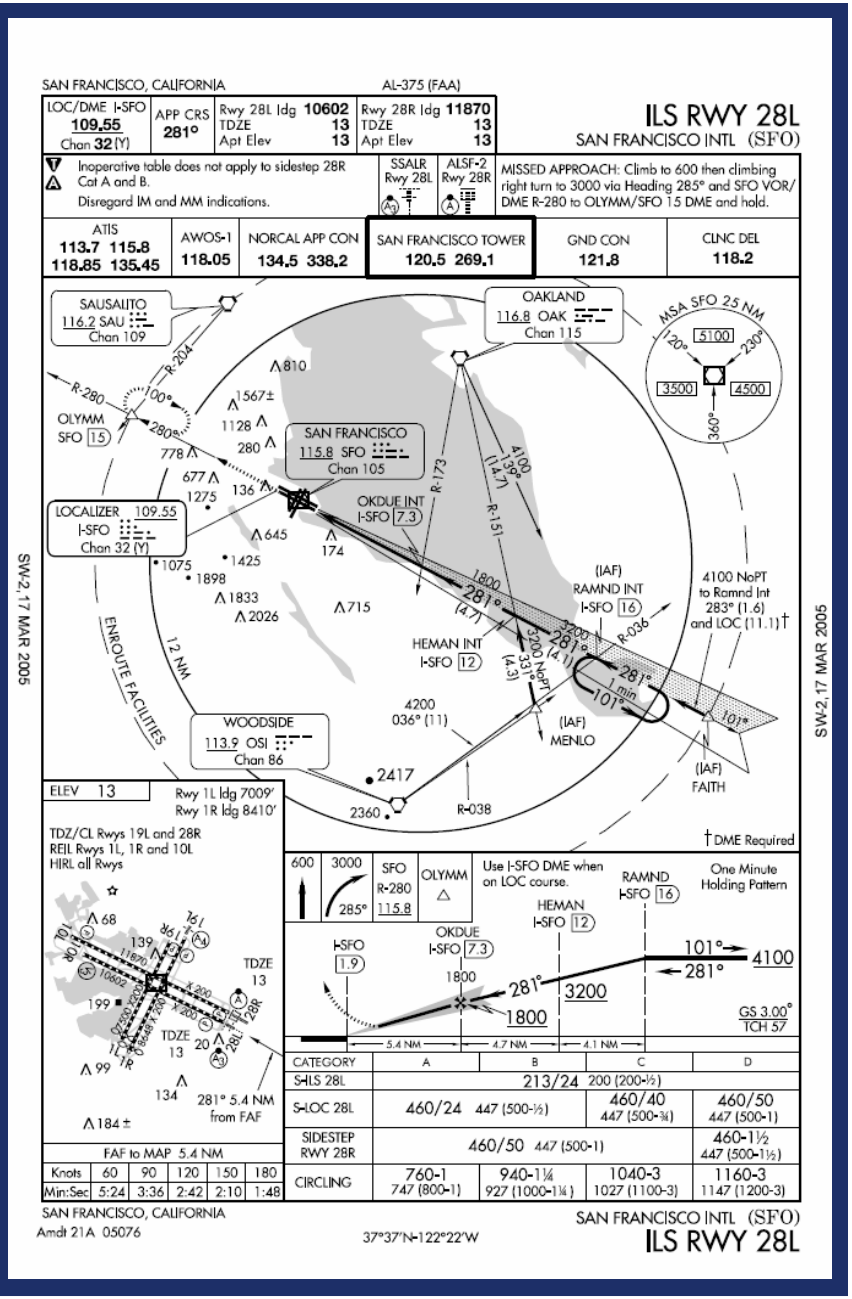
Standard Terminal Arrival Procedures (STAR):

- Most arrivals in a busy environment will be assigned a STAR.
- STAR's assist in delivering aircraft from the en-route environment to an instrument approach procedure.



Instrument Approach Procedures (IAP):

- IAP's are the guidance from the en-route environment to the airport.
- IAP's have different weather minimums based on speed of aircraft (or by company policy).



FAA Radar Systems

The FAA operates two basic radar systems:

- Airport Surveillance Radar (ASR);
- Air-Route Surveillance Radar (ARSR).

Both of these surveillance systems use primary (raw radar) and secondary (beacon) radar returns to give controllers aircraft position and speed information, plus altitude information from Mode C transponder equipped aircraft. Most ASR's provide 4.8 second sweeps (updates) while ARSR's provide 12 second sweeps.

Specialized Surveillance Systems

- Precision Runway Monitor (PRM) is a high-update-rate surveillance radar system for capacity-constrained airports. Certified to provide simultaneous independent approaches to closely spaced parallel runways, PRM enables ATC to improve the arrival rate when weather conditions require instrument approaches.
- The Precision Approach Radar (PAR) is designed to be used as a landing aid rather than an aid for sequencing and spacing aircraft. PAR equipment may be used as a primary landing aid or it may be used to monitor other types of approaches. It provides range, azimuth, and elevation information. In the U.S. PAR is used mostly by the military.

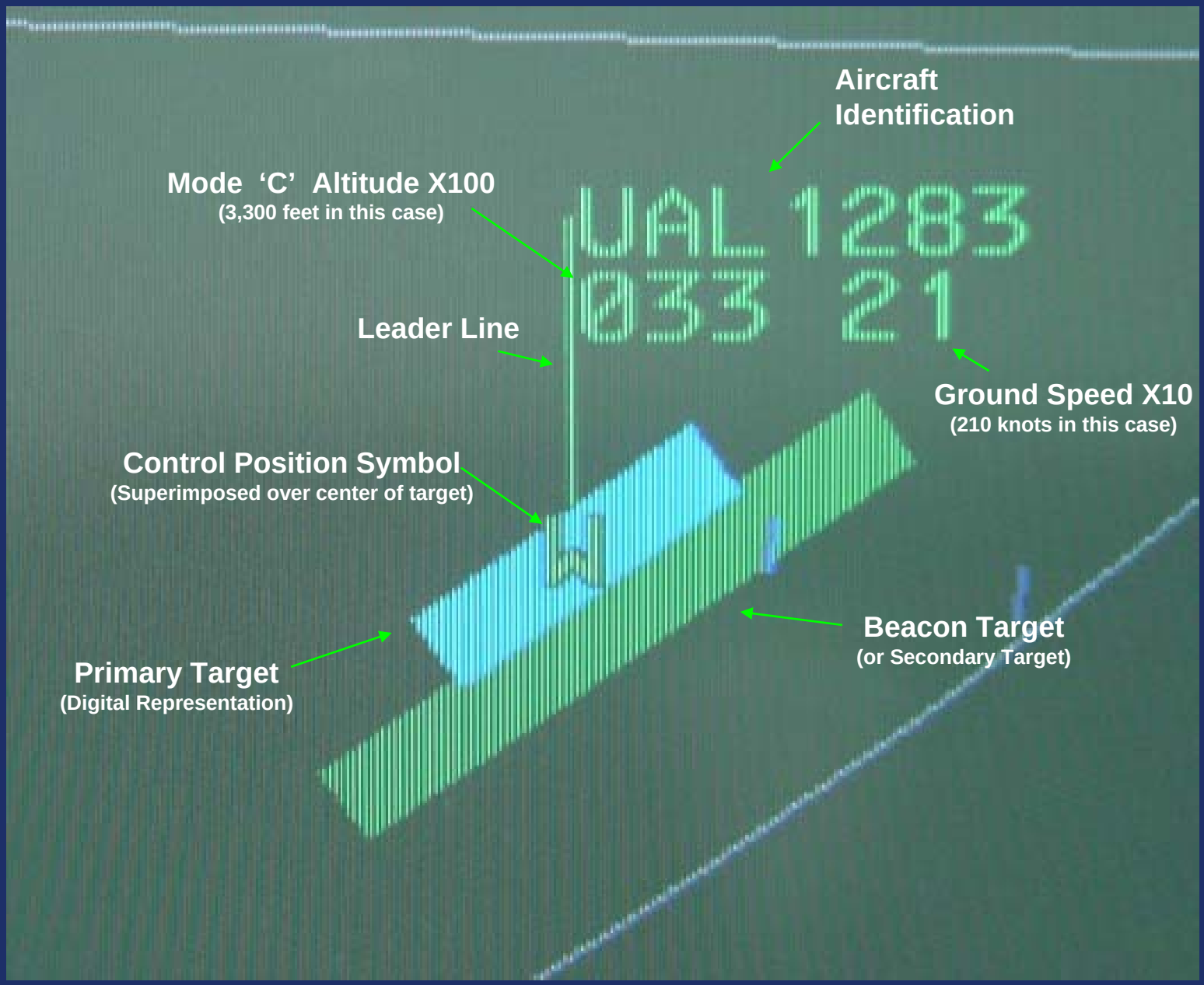
Terminal Automation Systems

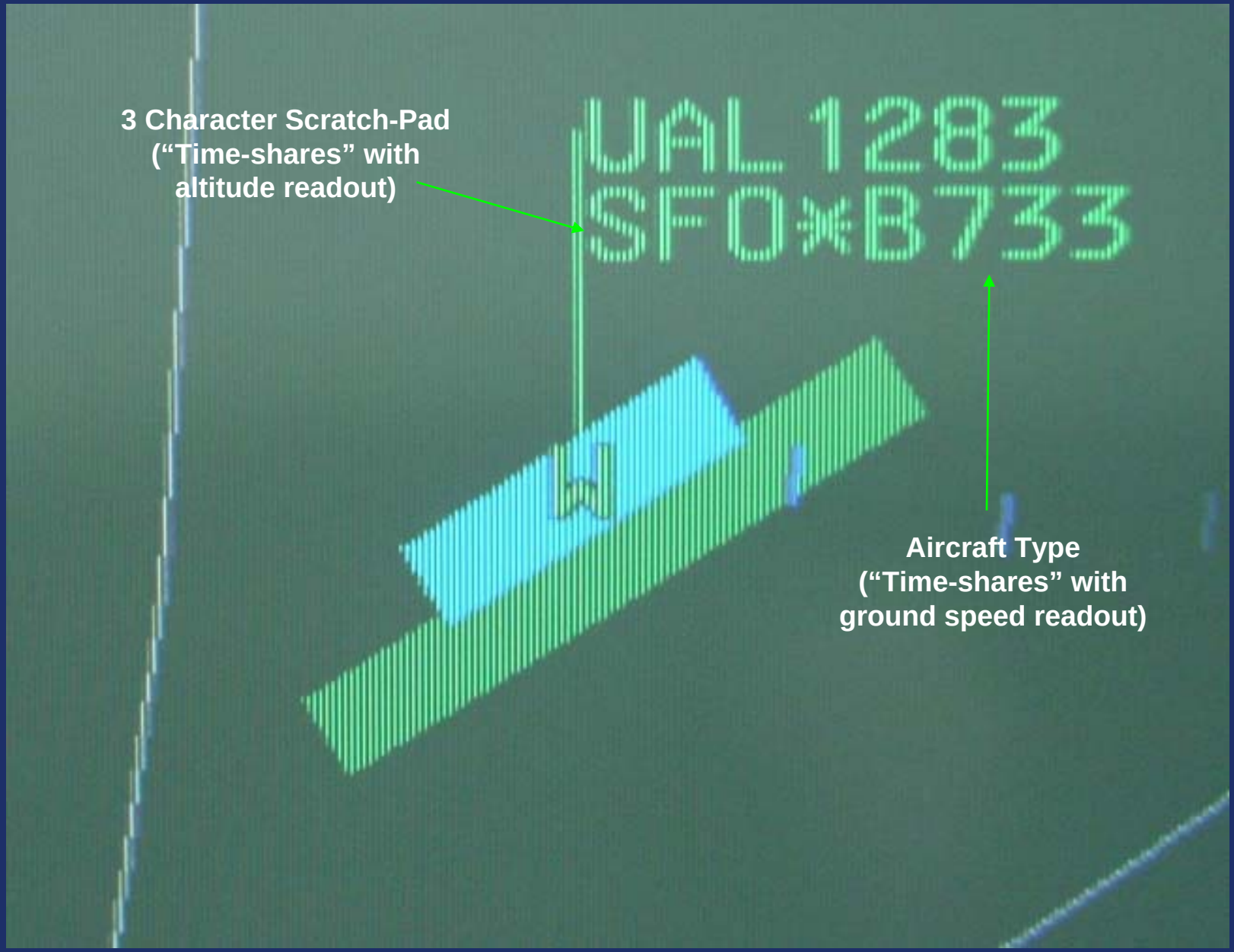
- A generic term for the computer system that tracks and provides a alpha-numeric label for select radar returns
- TAS facilitates intra- and inter-facility transfers and the coordination of flight information.
- Most TAS's have the capability of communicating with other TAS's as well as with the ARTCC.

Terminal Automation Systems (cont'd)

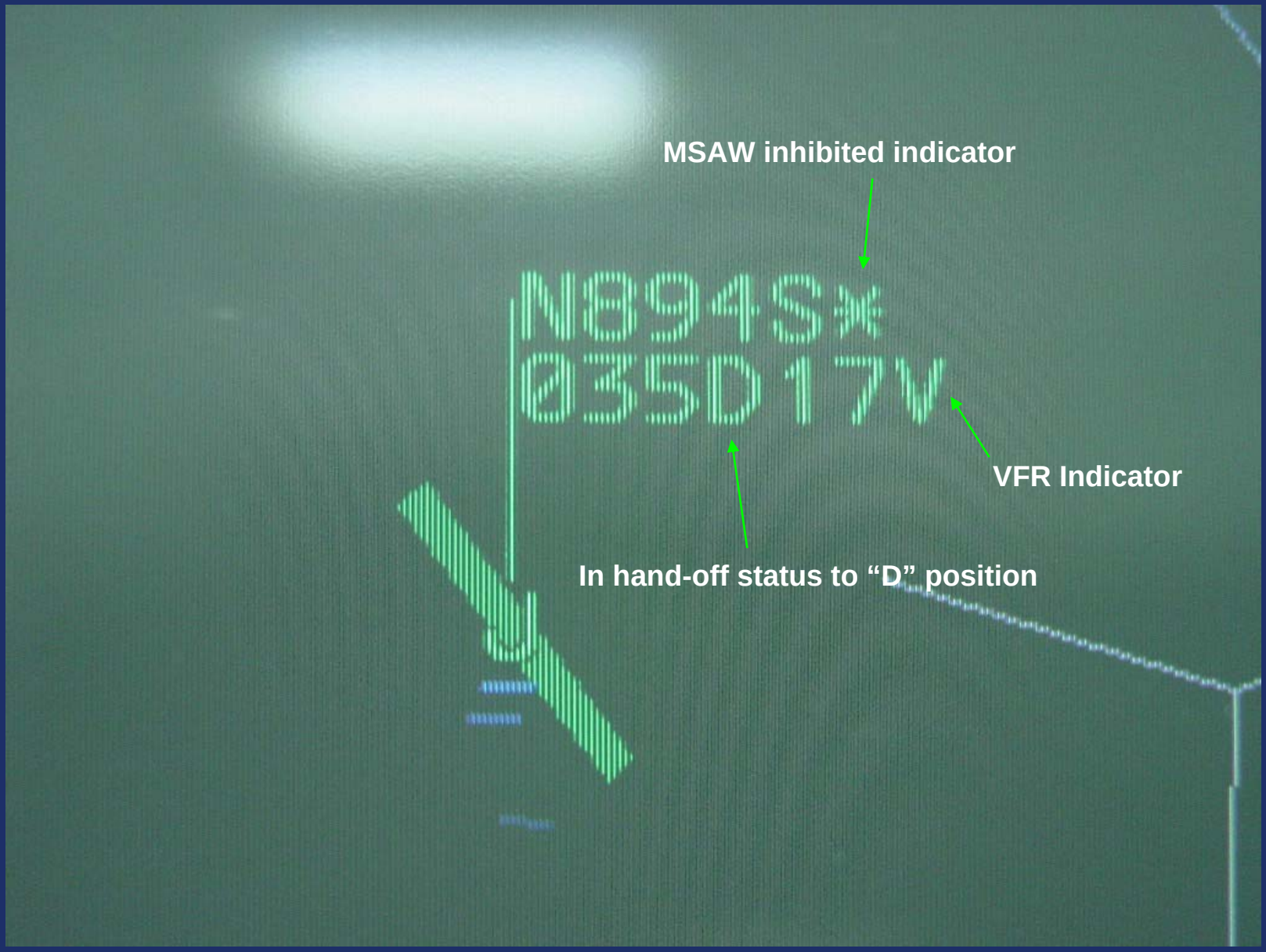
- Most common TAS is called ARTS (Automated Radar Tracking System)
- Replacement systems include Common ARTS and STARS (Standard Terminal Automated Replacement System)

ARTS Color Display (ACD)


Aircraft Identification
Mode 'C' Altitude X100
(3,300 feet in this case)
JAL 1283
233 21
Leader Line
Ground Speed X10
(210 knots in this case)
Control Position Symbol
(Superimposed over center of target)
Beacon Target
(or Secondary Target)
Primary Target
(Digital Representation)



ARTS IIIe Full Data Block (Cont'd)



ARTS IIIe Full Data Block (Cont'd)

Radar Identification Methods

- **Primary:**
  - Observing a departing aircraft target within 1 mile of the takeoff runway end at airports with an operating control tower.
  - Observing a target whose position with respect to a fix (displayed on the video map, scribed on the map overlay, or displayed as a permanent echo) or a visual reporting point.
  - Observing a target make an identifying turn or turns of 30 degrees or more.

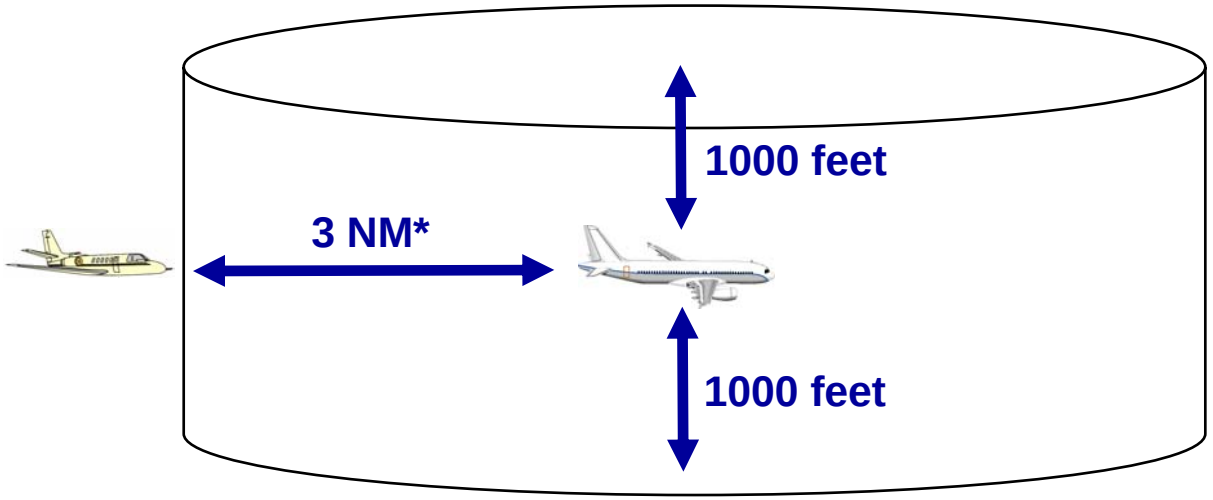
Radar Identification Methods

Using Automation:

- Request the aircraft to activate the "IDENT" feature of the transponder and then observe the identification display.
- Request the aircraft to change to a specific discrete or non-discrete code, as appropriate, and then observe the target or code display change.
- Request the aircraft to change transponder to "standby." After you observe the target disappear for sufficient scans to assure that loss of target resulted from placing the transponder in "standby" position, request the aircraft to return transponder to normal operation and then observe the reappearance of the target.

Terminal Radar Separation

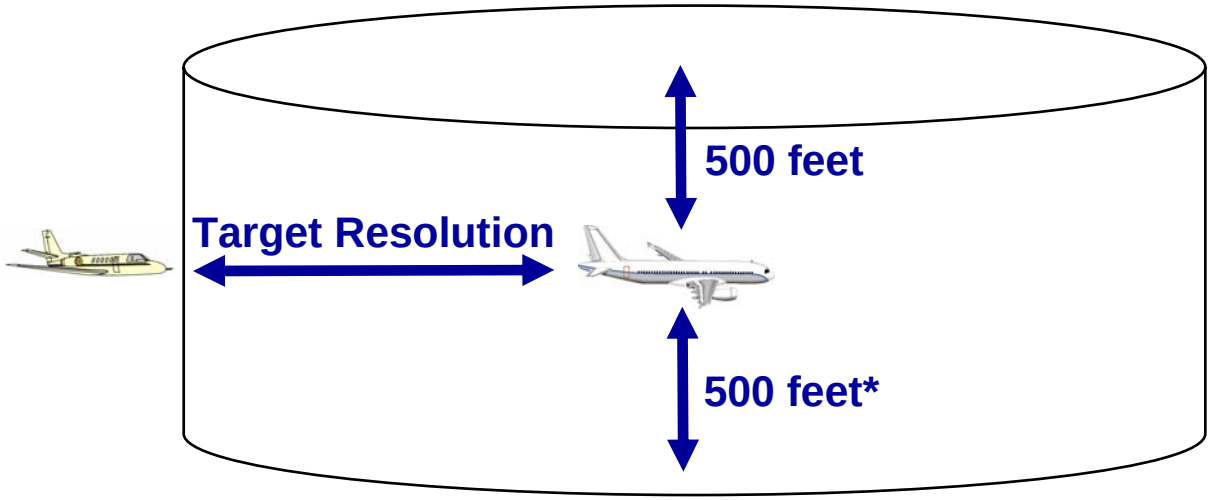
- IFR vs IFR regardless of airspace



* 5NM when operating behind a “heavy jet” (B747, B767, B777, MD11, A380 for examples), 40NM or more from the radar antenna, or when using multiple (mosaic) radar data sources.

Terminal Radar Separation

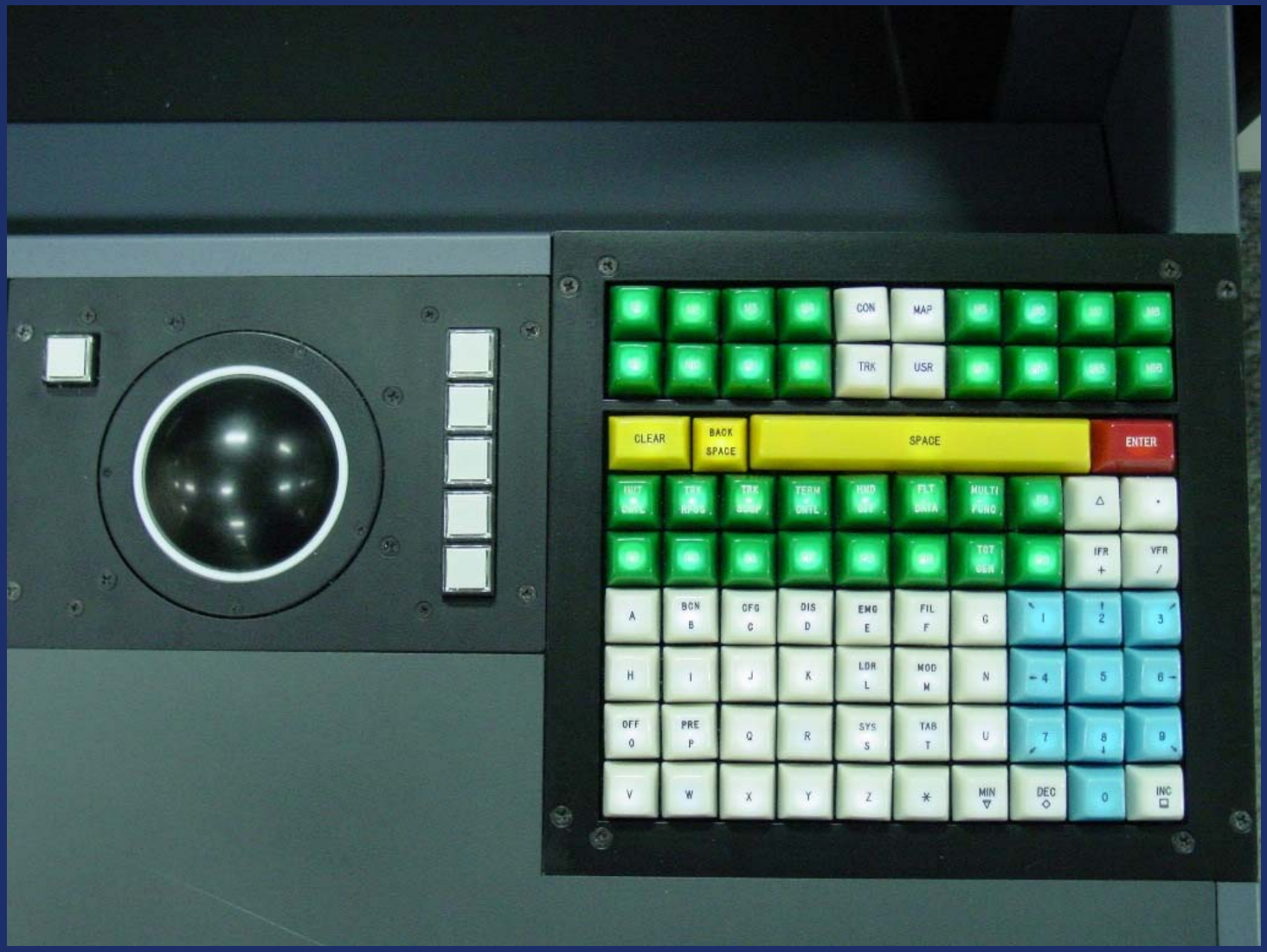
- IFR vs VFR in Class B/C airspace



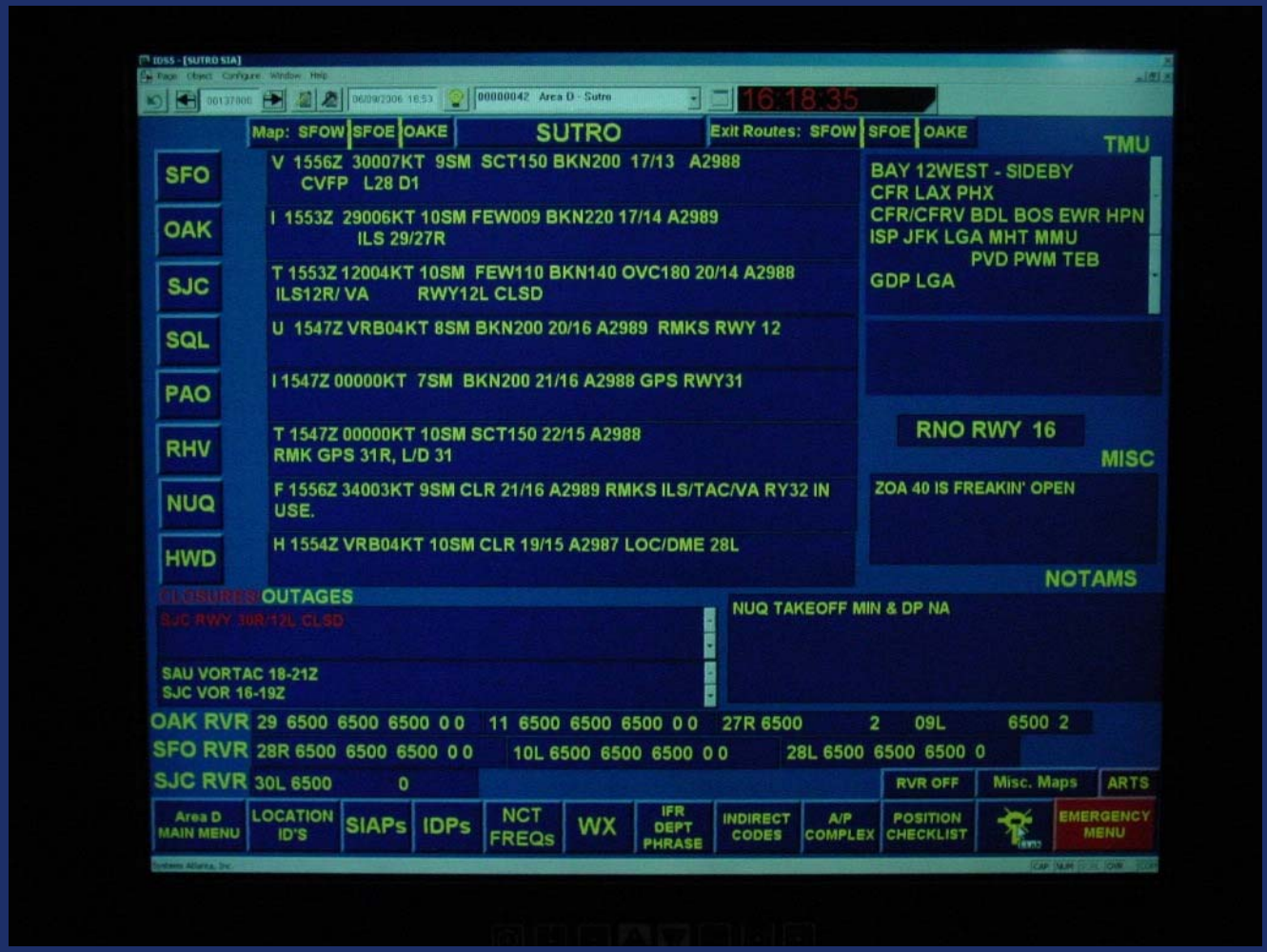
*1,000 when operating below a “heavy jet”
(For example: B747, B767, B777, MD11, A380).

TRACON ATC Position

ARTS Keyboard & Trackball



Controller Information Display (ACE-IDS)



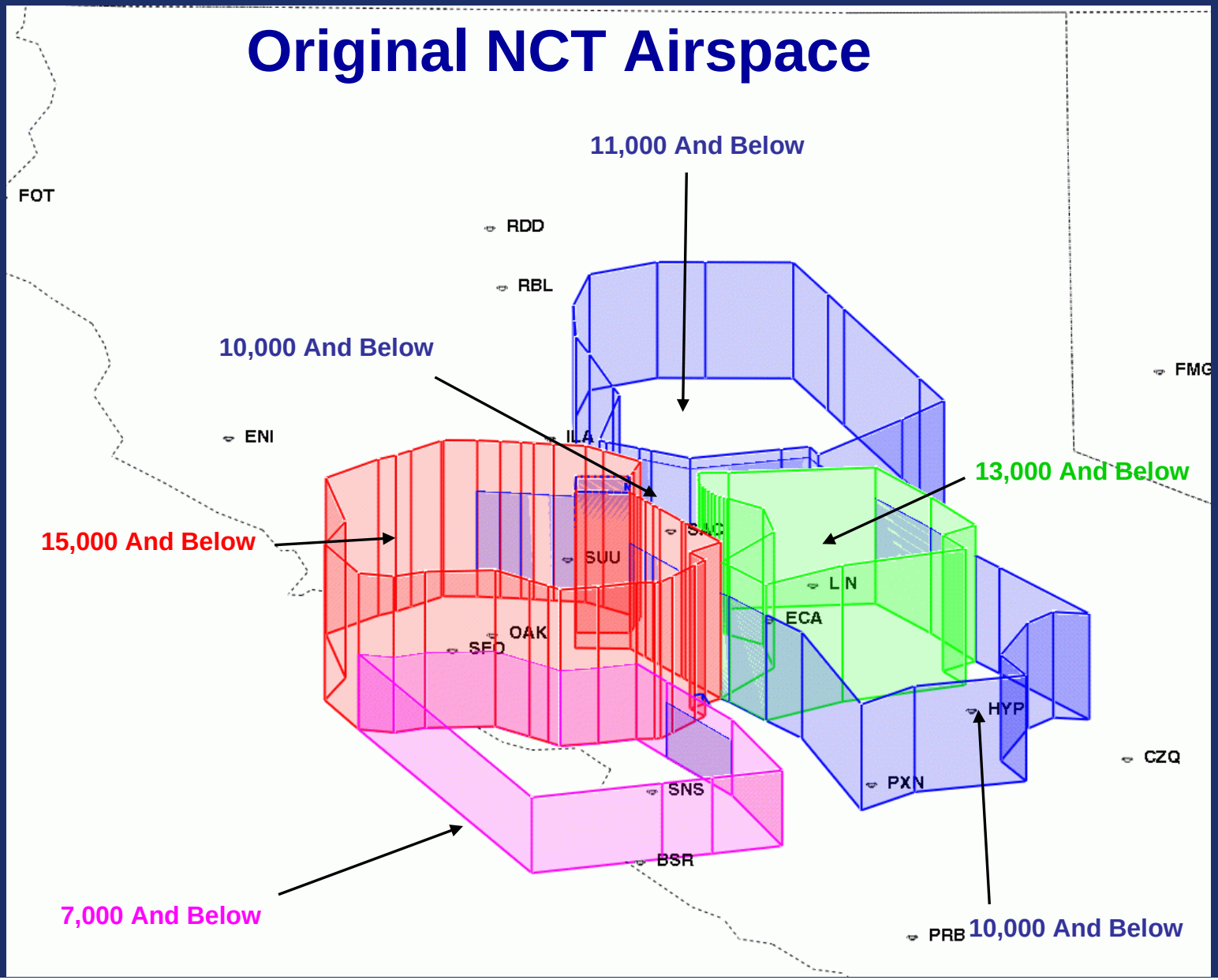
Terminal Training

- **FAA Academy (Oklahoma City) - 12 weeks**
  - Fundamentals of aviation and ATC
  - Classroom and simulation labs
- **Field Facility**
  - Classroom (local airspace and procedures):
    4 to 12 weeks depending on facility
  - OJT:
    6 to 30 months to facility certification

Current NCT Airspace

- Area of 17,156 square nautical miles
- 9,051 square nautical miles is FL230 and below
- 8,105 square nautical miles is FL190 and below
- Seven ASR terminal primary radar systems
- Three ARSR back-up enroute radar systems

Original NCT Airspace



NCT Airspace

Divided into:

5 Operational Areas

5 Areas are divided into:

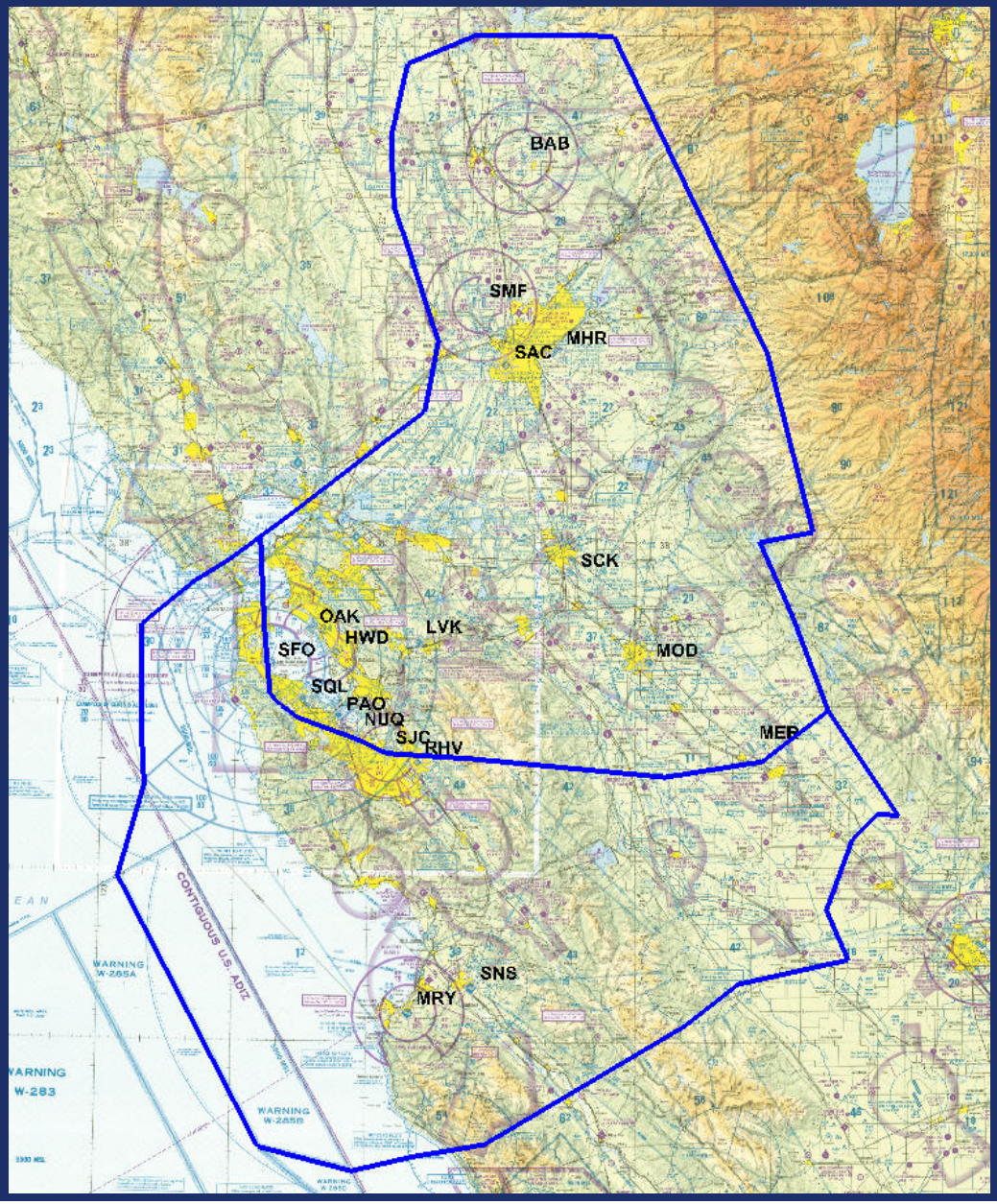
A – 7 sectors

B – 6 sectors

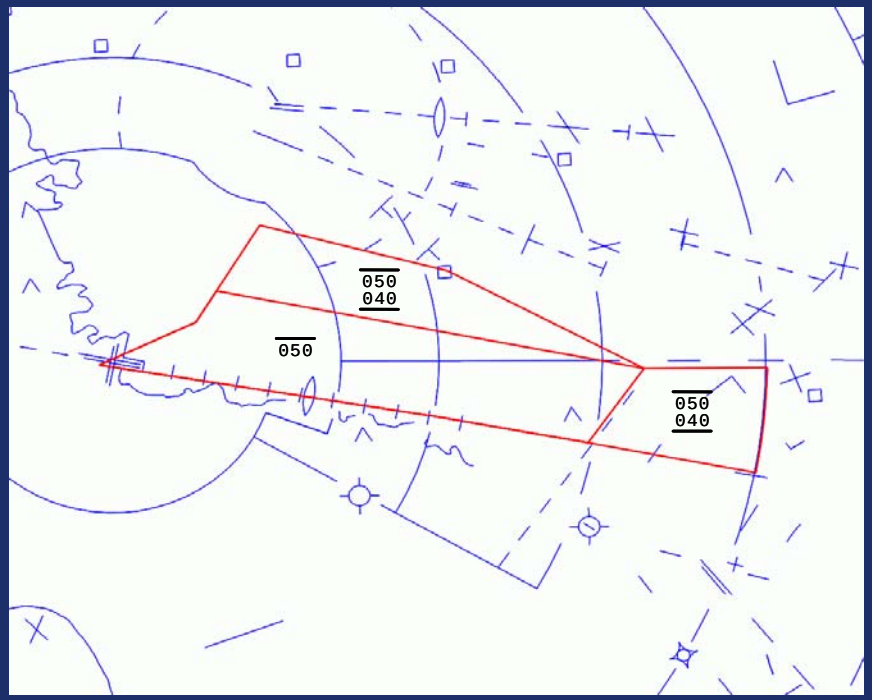
C – 6 sectors

D – 5 sectors

E – 6 sectors

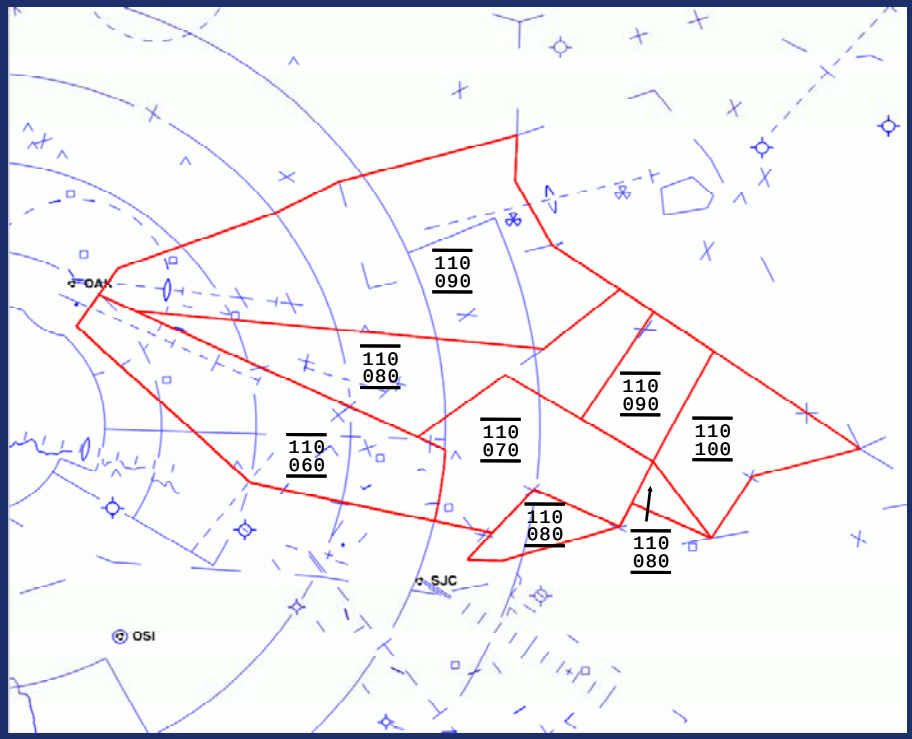


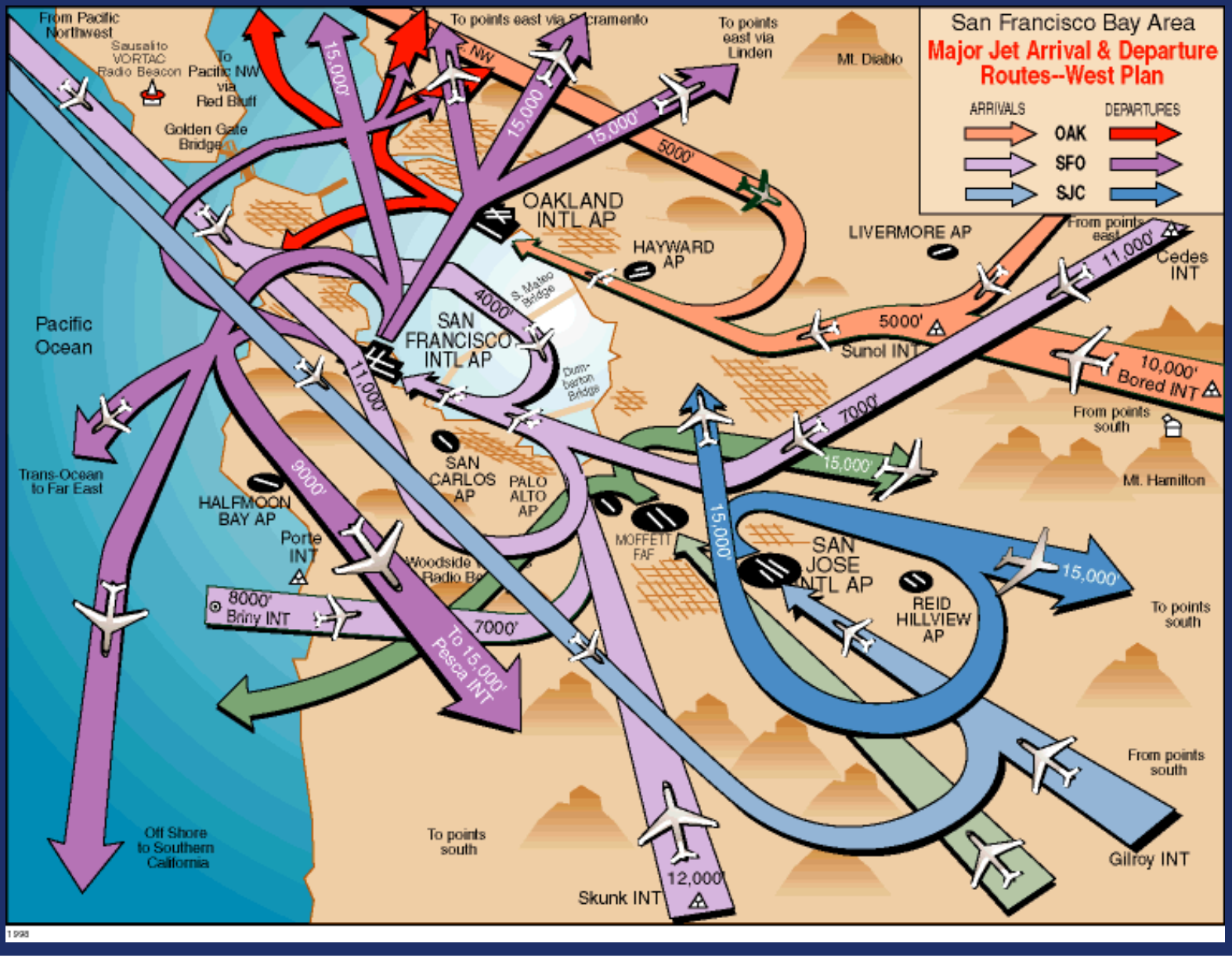
Examples of NCT Sectors

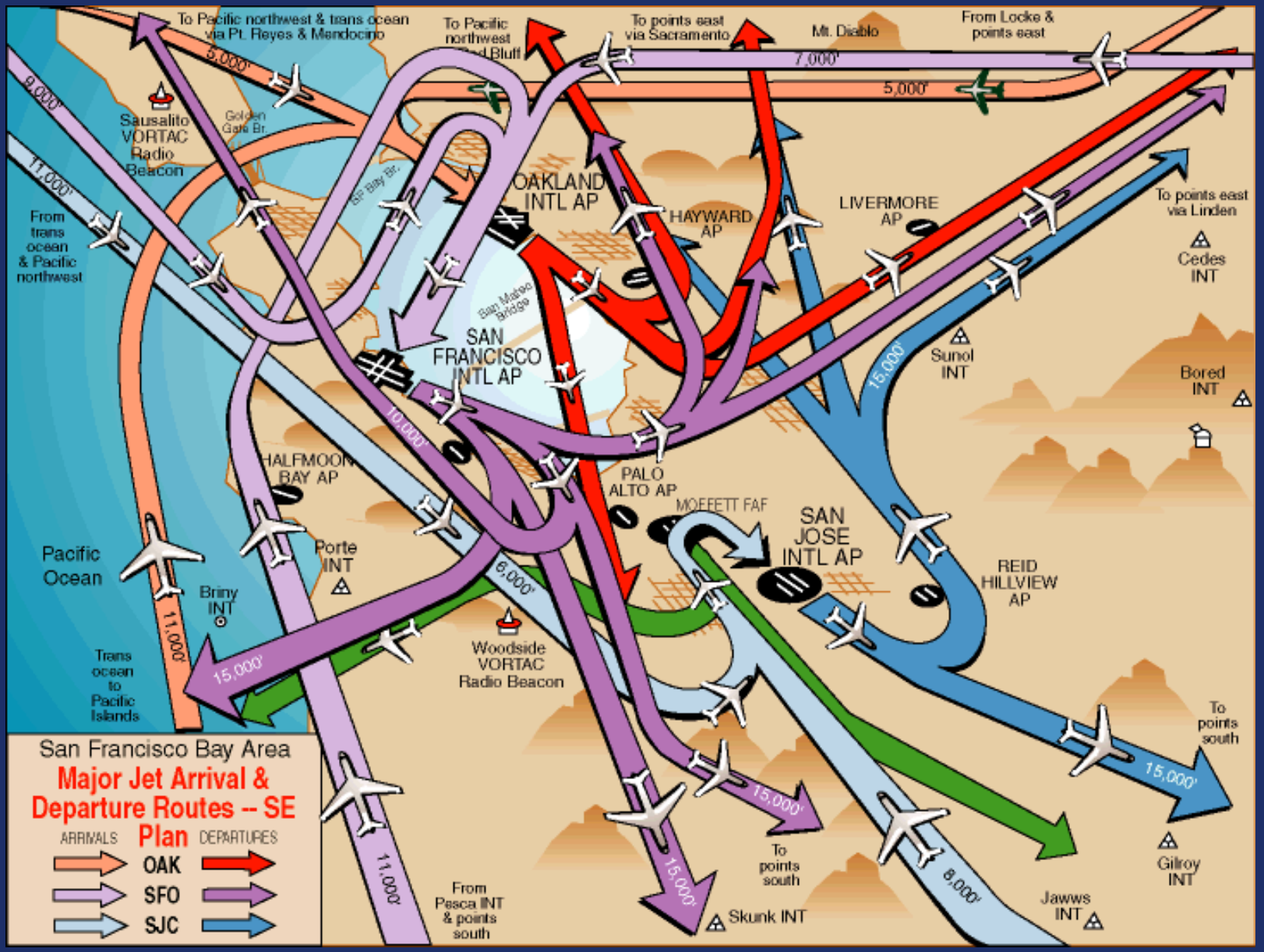


Foster - West Plan

Niles – West Plan



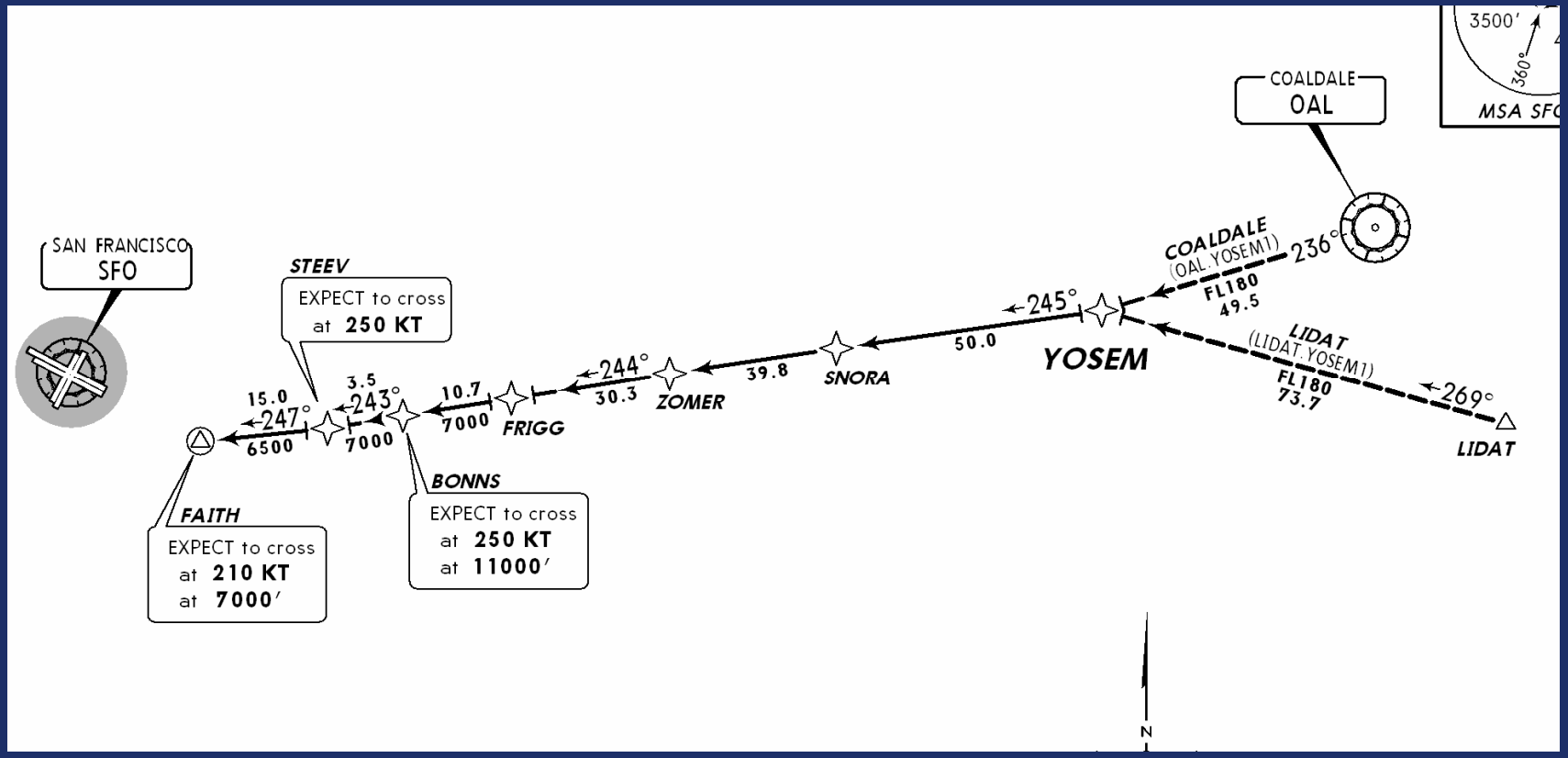

San Francisco Bay Area
Major Jet Arrival & Departure Routes--West Plan
ARRIVALS
DEPARTURES
OAK
SFO
SJC
From Pacific Northwest
Sausalito VORTAC Radio Beacon
To Pacific NW via Red Bluff
Golden Gate Bridge
To points east via Sacramento
To points east via Linden
Mt. Diablo
15,000'
5000'
OAKLAND INTL AP
HAYWARD AP
LIVERMORE AP
From points east
11,000'
Cedes INT
Pacific Ocean
SAN FRANCISCO INTL AP
4000'
5000'
Sunol INT
10,000'
Bored INT
From points south
7000'
11,000'
Trans-Ocean to Far East
SAN CARLOS AP
PALO ALTO AP
HALFMOON BAY AP
9000'
Porte INT
MOFFETT FAF
SAN JOSE INTL AP
REID HILLVIEW AP
15,000'
Mt. Hamilton
8000'
Briny INT
7000'
To 15,000'
Pesca INT
To points south
Off Shore to Southern California
To points south
12,000'
Skunk INT
From points south
Gilroy INT


To Pacific northwest & trans ocean via Pt. Reyes & Mendocino
To Pacific northwest
To points east via Sacramento
Mt. Diablo
From Locke & points east
5,000'
7,000'
5,000'
9,000'
11,000'
Sausalito VORTAC Radio Beacon
Golden Gate Br.
SF Bay Br.
OAKLAND INTL AP
HAYWARD AP
LIVERMORE AP
To points east via Linden
Cedes INT
From trans ocean & Pacific northwest
San Mateo Bridge
SAN FRANCISCO INTL AP
Sunol INT
15,000'
Bored INT
10,000'
HALFMOON BAY AP
PALO ALTO AP
MOFFETT FAF
SAN JOSE INTL AP
REID HILLVIEW AP
Pacific Ocean
Porte INT
Briny INT
6,000'
11,000'
15,000'
Trans ocean to Pacific Islands
Woodside VORTAC Radio Beacon
To points south
15,000'
15,000'
To points south
Gilroy INT
11,000'
From Pesca INT & points south
15,000'
Skunk INT
8,000'
Jawws INT
San Francisco Bay Area
Major Jet Arrival & Departure Routes -- SE Plan
ARRIVALS
DEPARTURES
OAK
SFO
SJC

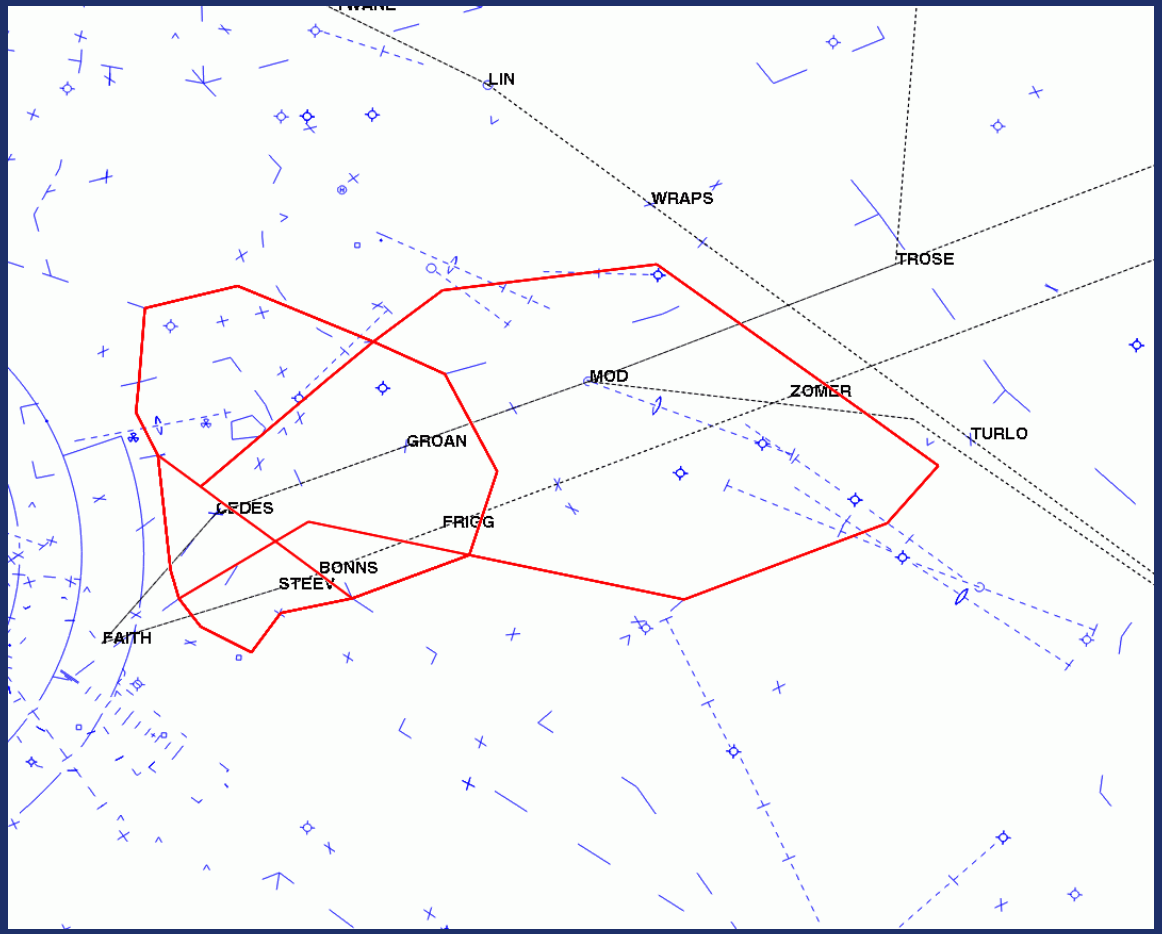
What's Up at NCT?

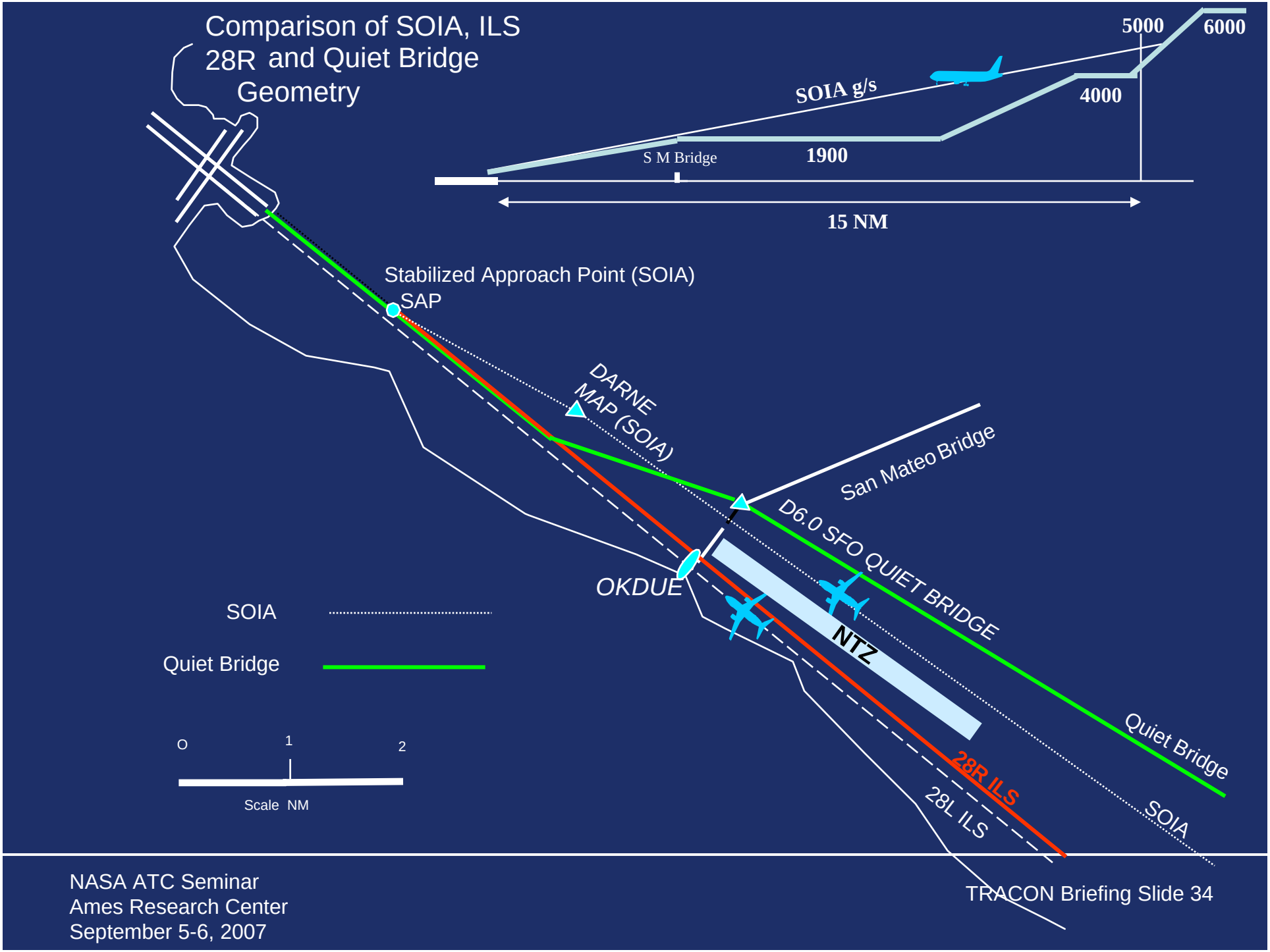
- **Dual Arrival Routes**
- **SOIA**
- **SOIA Enhancements**
  - New Approach Plates
  - Wake Protection Zone Software
- **GALTS Gate or Transition**
- **Oceanic Tailored Arrivals into SFO**
- **Global Hawk**

YOSEM RNAV STAR into SFO

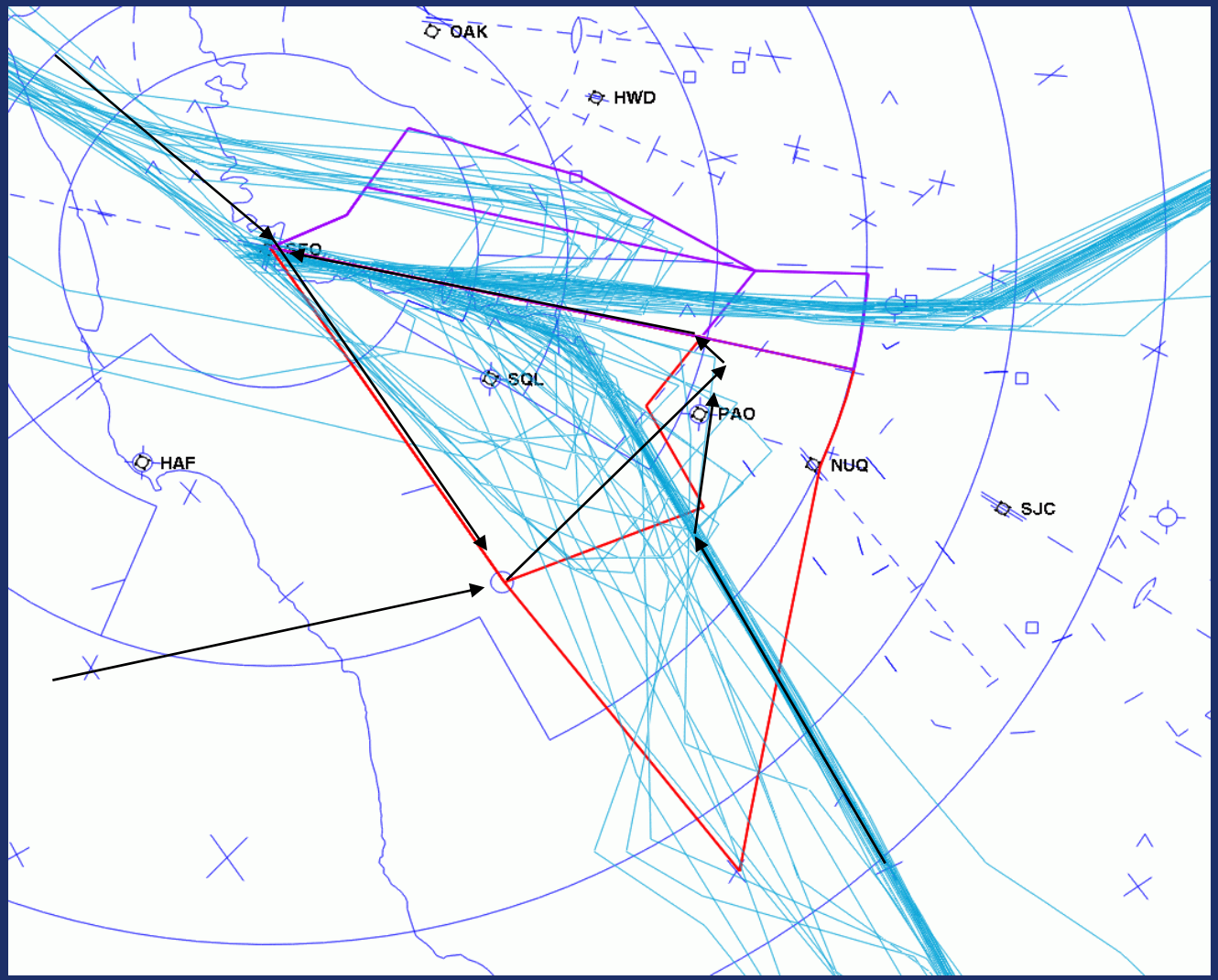


NCT SFO Dual Arrival Routes

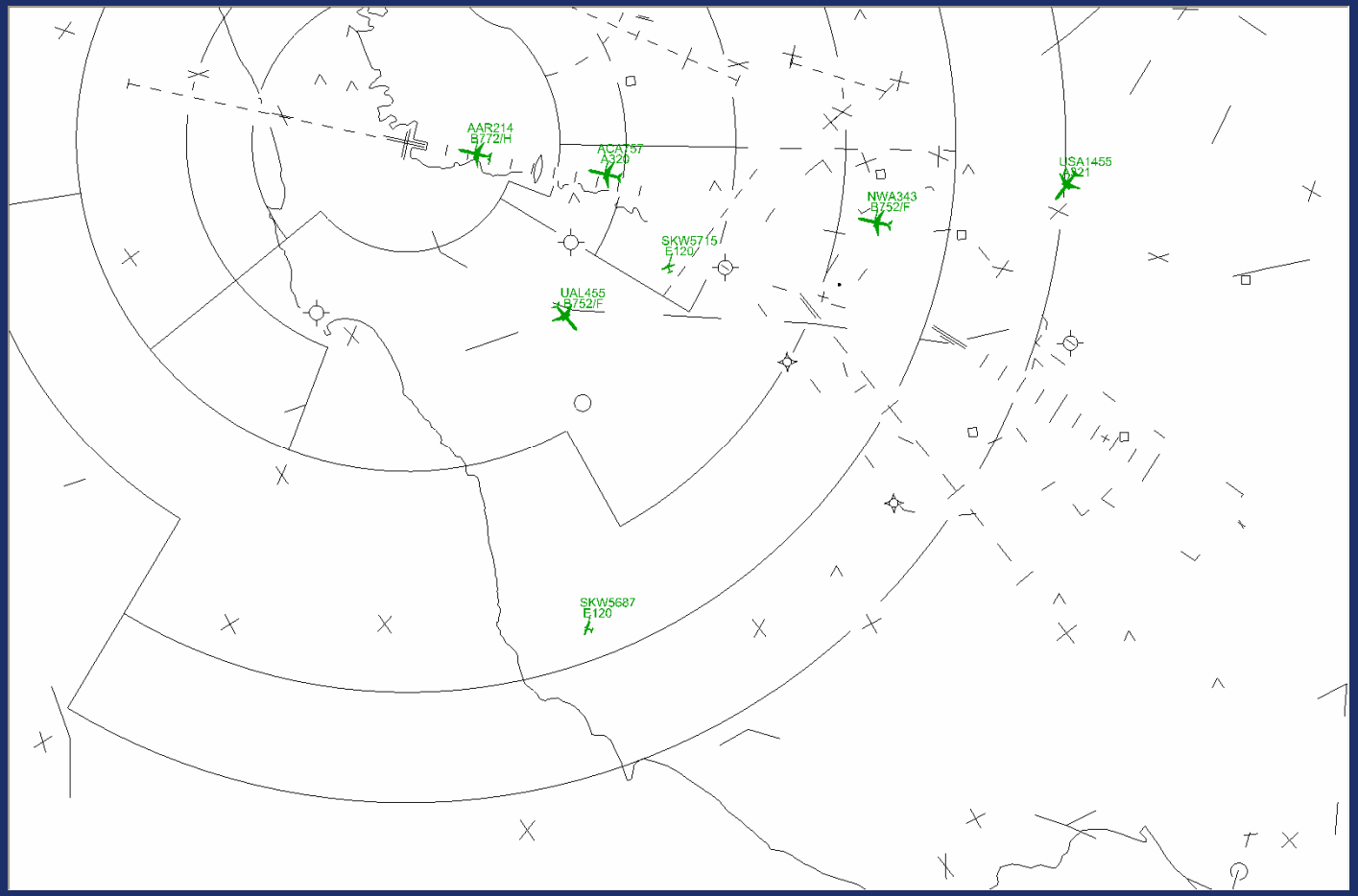



Comparison of SOIA, ILS 28R and Quiet Bridge Geometry
5000
6000
SOIA g/s
4000
S M Bridge
1900
15 NM
Stabilized Approach Point (SOIA)
SAP
DARNE
MAP (SOIA)
San Mateo Bridge
D6.0 SFO QUIET BRIDGE
OKDUE
SOIA
Quiet Bridge
NTZ
28R ILS
28L ILS
Quiet Bridge
SOIA
O
1
2
Scale NM

SFO Traffic Flow with SOIA Over



SFO Simultaneous Offset Instrument Approaches



SFO SOIA/PRM Runways 28 L/R

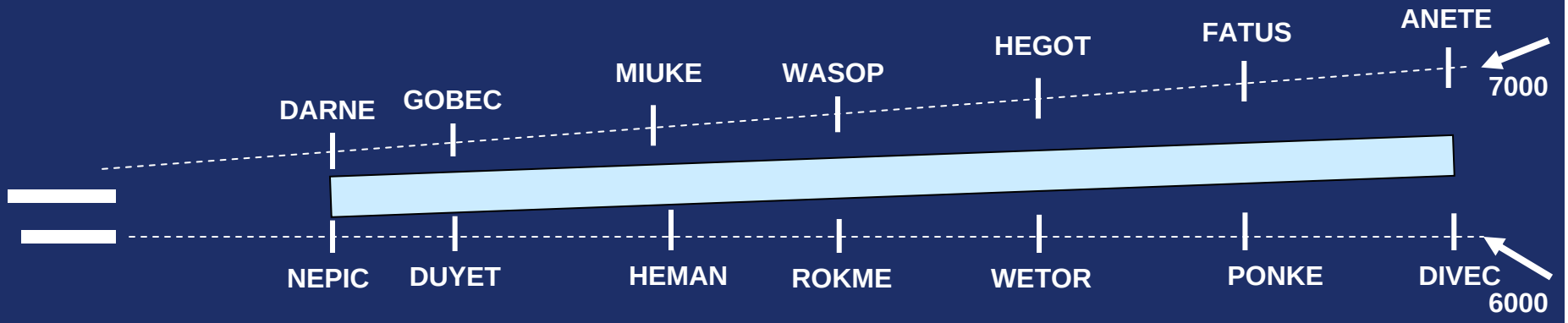
Date	Time	Actual Arrival Numbers
10/27/04	**1539Z-1639Z**	**35**
3/22/05	**0050Z-0150Z**	**35**
3/23/05	**1900Z-2000Z**	**42**
4/11/05	**1810Z-1910Z**	**39**
6/17/05	**1620Z-1720Z**	**38**
10/19/05	**1800Z-1900Z**	**42**
9/30/06	**1600Z-1700Z**	**40**
1/31/07	**1800Z-1900Z**	**39**

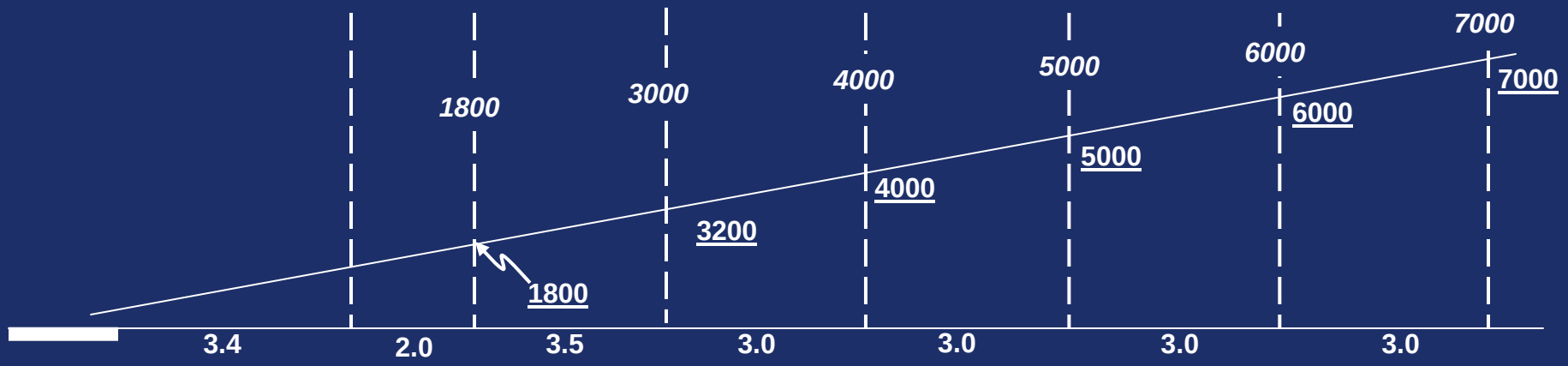
SOIA Gained Efficiencies 10/04 – 3/06

Examples:

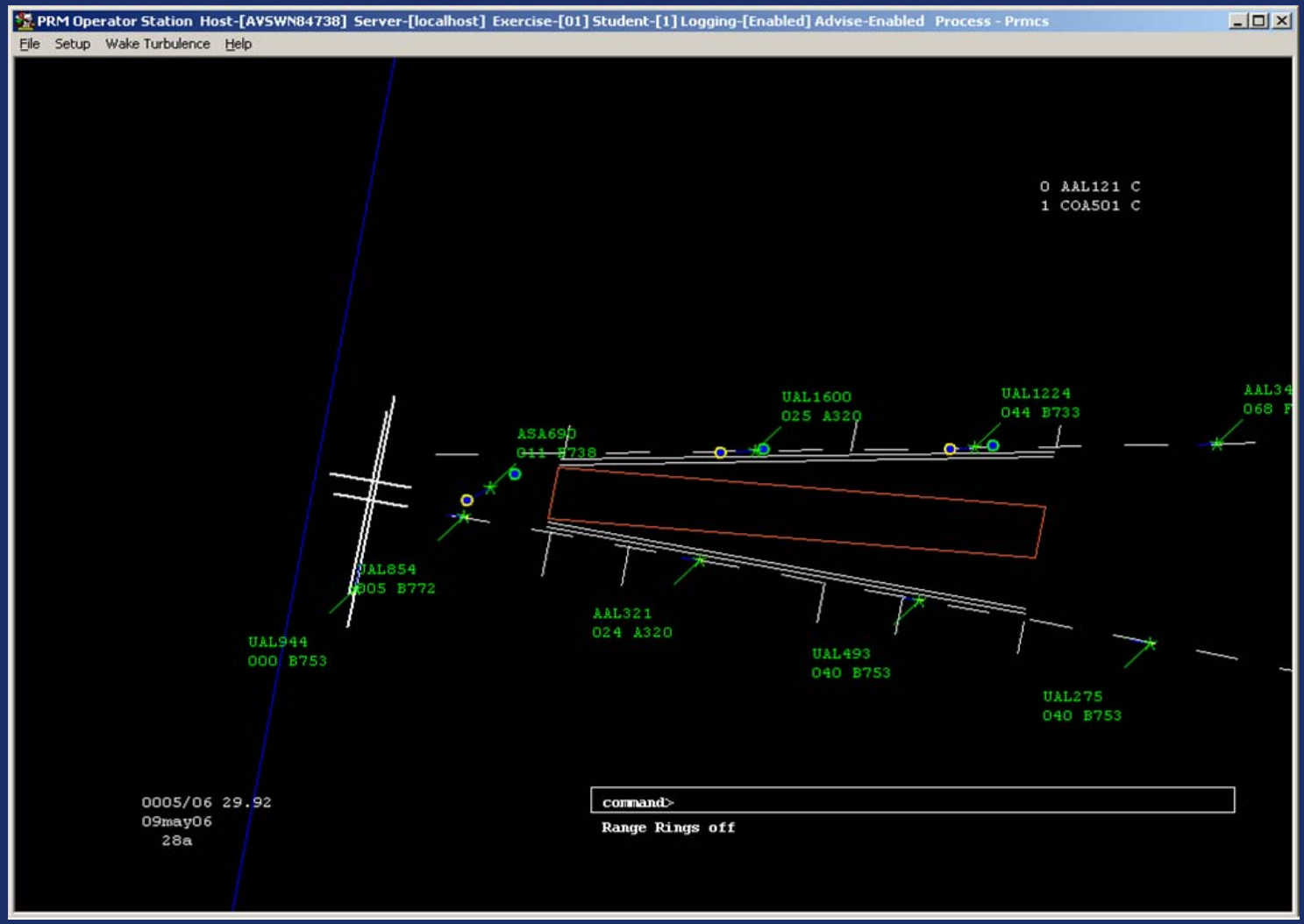
- **NCT/SFO ran SOIA 23 times in lieu of GDPs**
- **NCT/ATCSCC avoided a GDP 18 times by having SOIA as a fall-back option**
- **NCT avoided airborne holding or initiating a ground stop at least 49 times**

Revised SOIA Approaches

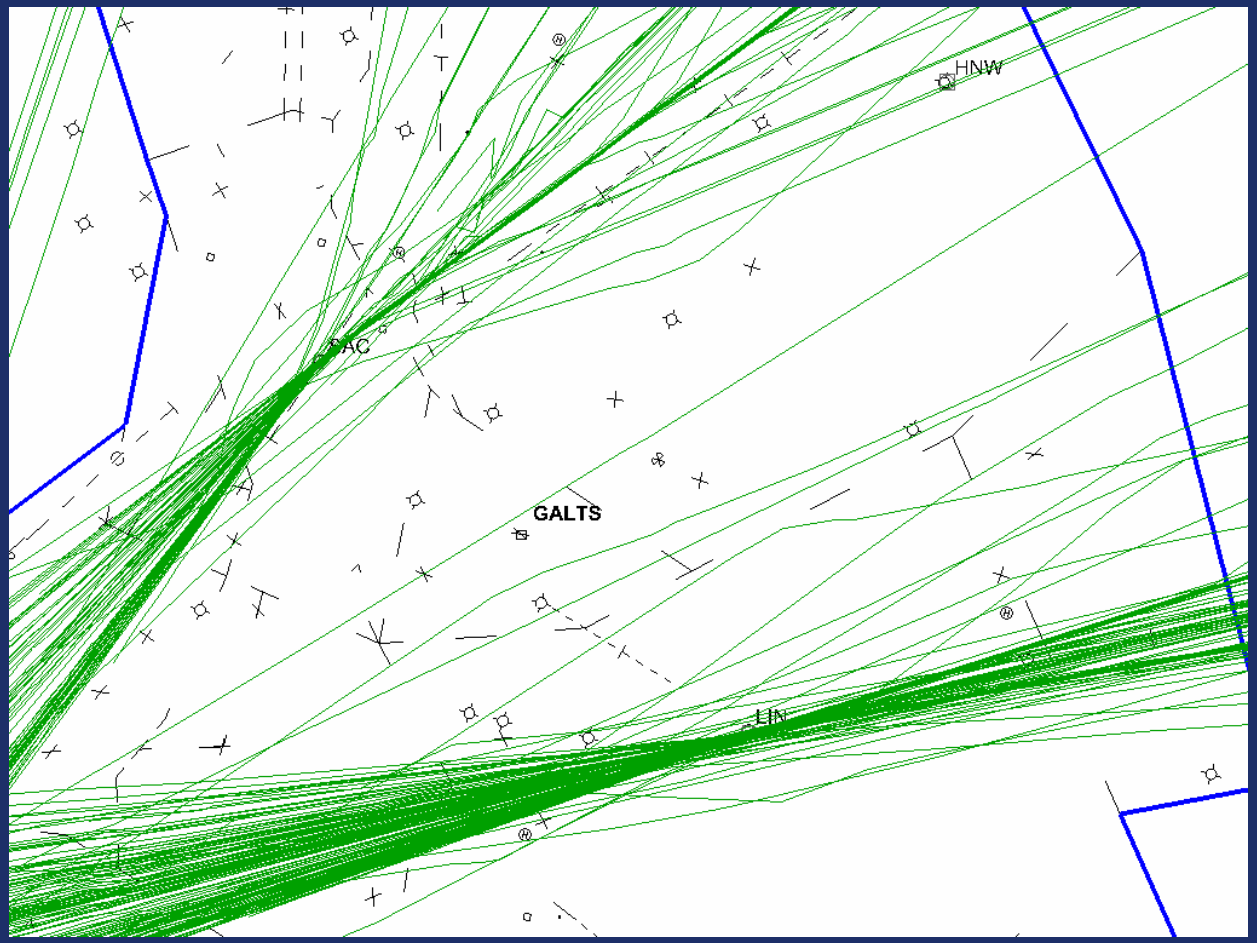




SOIA Wake Protection Zone Concept



GALTS Departure Gate/Transition



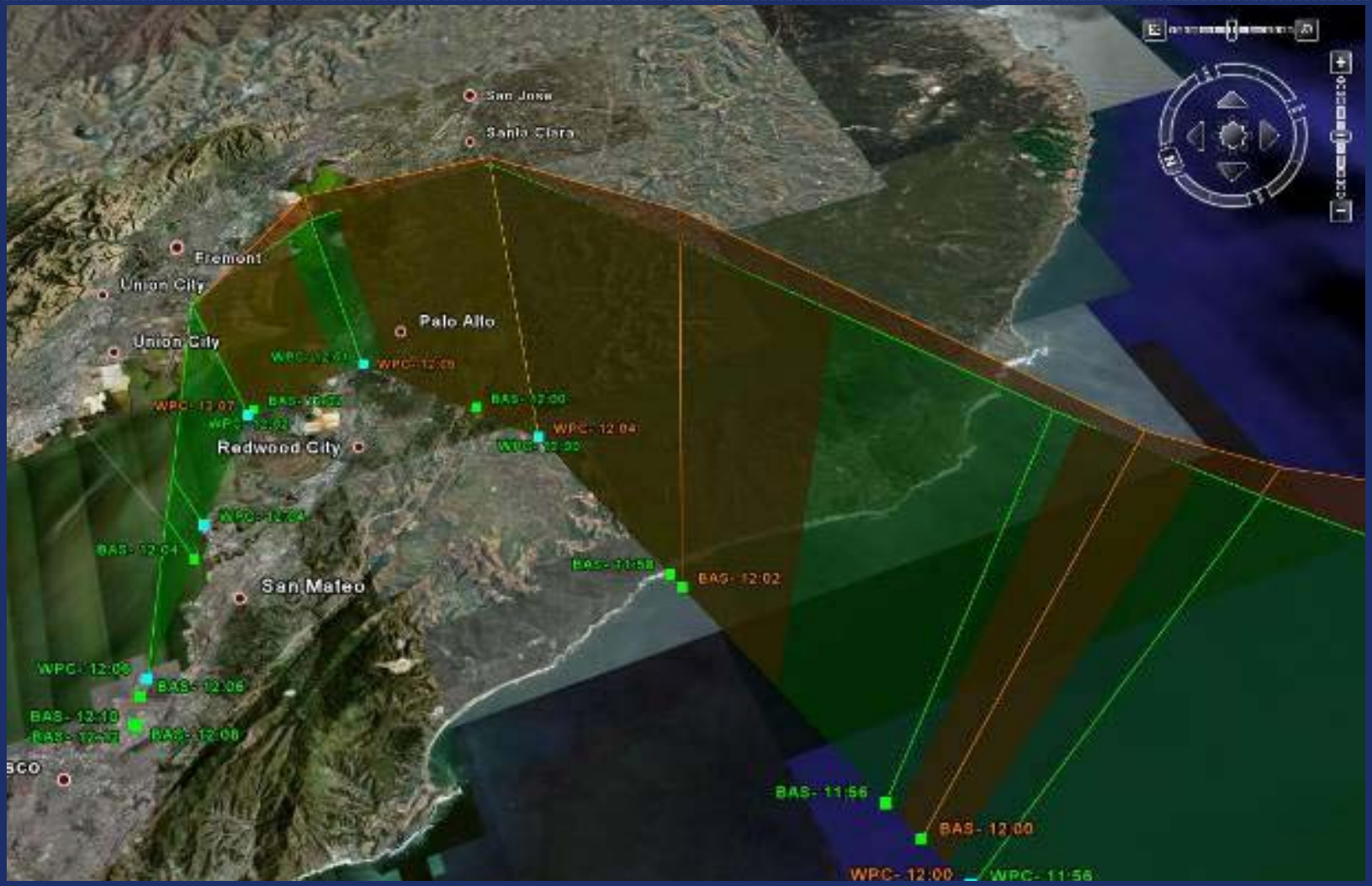
Benefits of GALTS Departure

More efficient use of airspace

Reduces number of aircraft on LIN route off SFO, OAK, SJC

Possible Reduction in Traffic Management Initiatives (miles-in-trail)

SFO Operational OTA Trials



SFO OTA Development Process

- Procedures, phraseology, support material were developed cooperatively
- Initial simulation assessment conducted
- Profile and procedures revised
  - Pilot/controller interviews/questionnaires
  - Facility observations
  - Nightly reports

Initial Trial Period

- August 17, 2006. until September 5, 2006
- Dec 15, 2006 and January 9, 2007
- 40 OTA opportunities
  - 35 attempts
  - 35 successful uplinks
  - 27 successful wind uplinks
  - 26 successful thru Oceanic/En Route airspace
  - 20 successful thru Terminal airspace

Operational Assessment

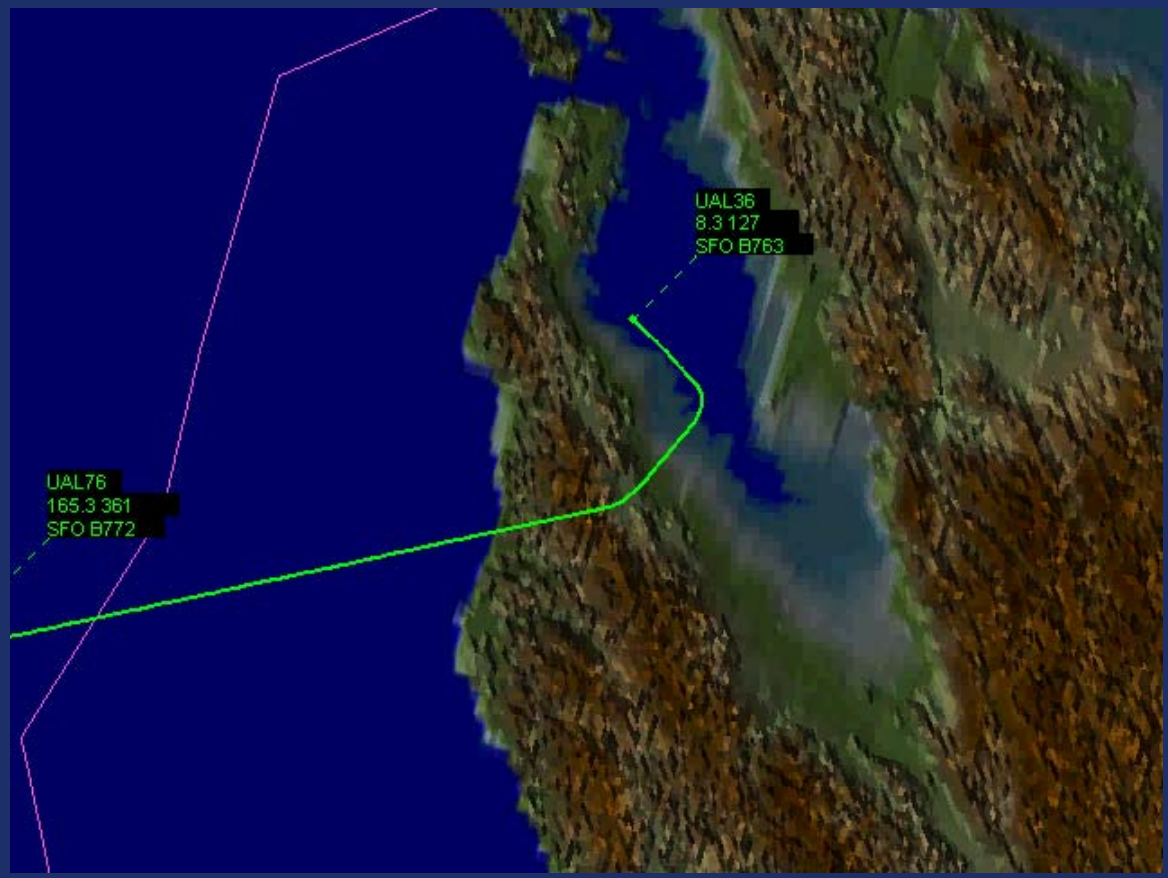
Terminal Perspective

- Confusion among pilots over difference between clearance altitude and profile altitude (8000 vs. 7000)
- Confusion among pilots reference current noise procedures (again, 8000 is standard over OSI, profile used 7000)
- Using 7000 at OSI may have generated unnecessary noise over noise sensitive communities
- Procedurally, OTA is not currently an official mechanism – procedure is not a STAR and not an SIAP
- Air Traffic rules require standard or special IAP clearance
- OTA trials were successful as long as the test aircraft was first with no competition for airspace

All SFO Arrivals for January 5, 2007

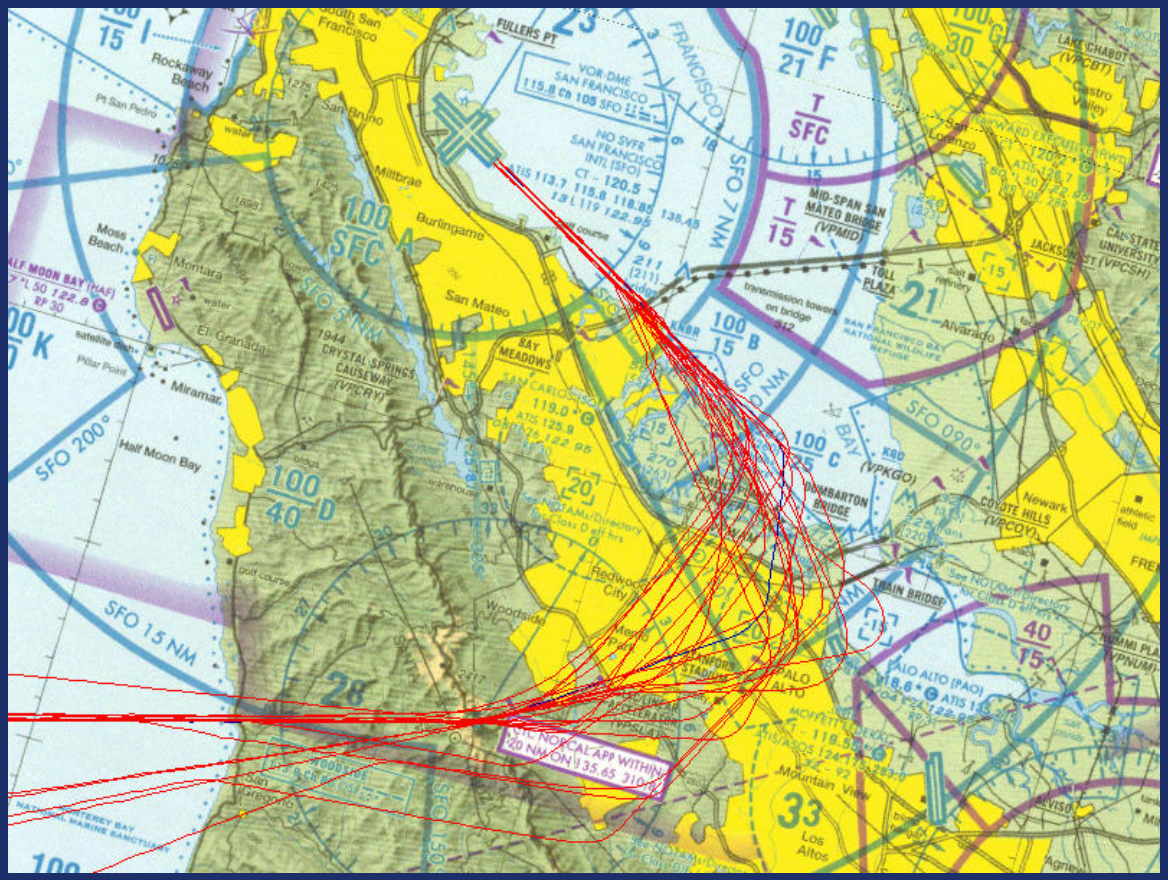
Operational Assessment

Able to accommodate arrival due to low traffic levels



Operational Assessment

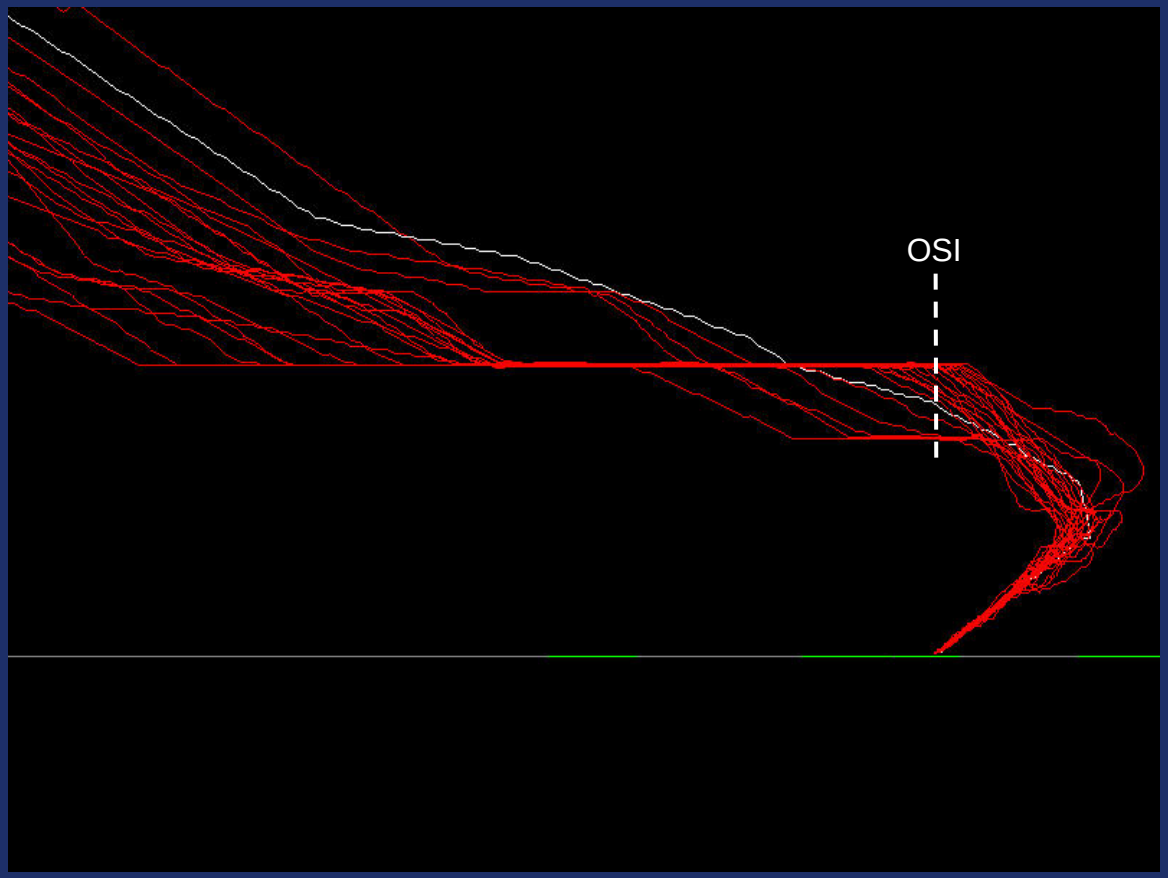
Lateral profiles of all oceanic arrivals during 24-hour period
UAL 76 – Dark Track



Operational Assessment

Vertical profiles of all oceanic arrivals during 24-hour period

UAL 76 – White Track

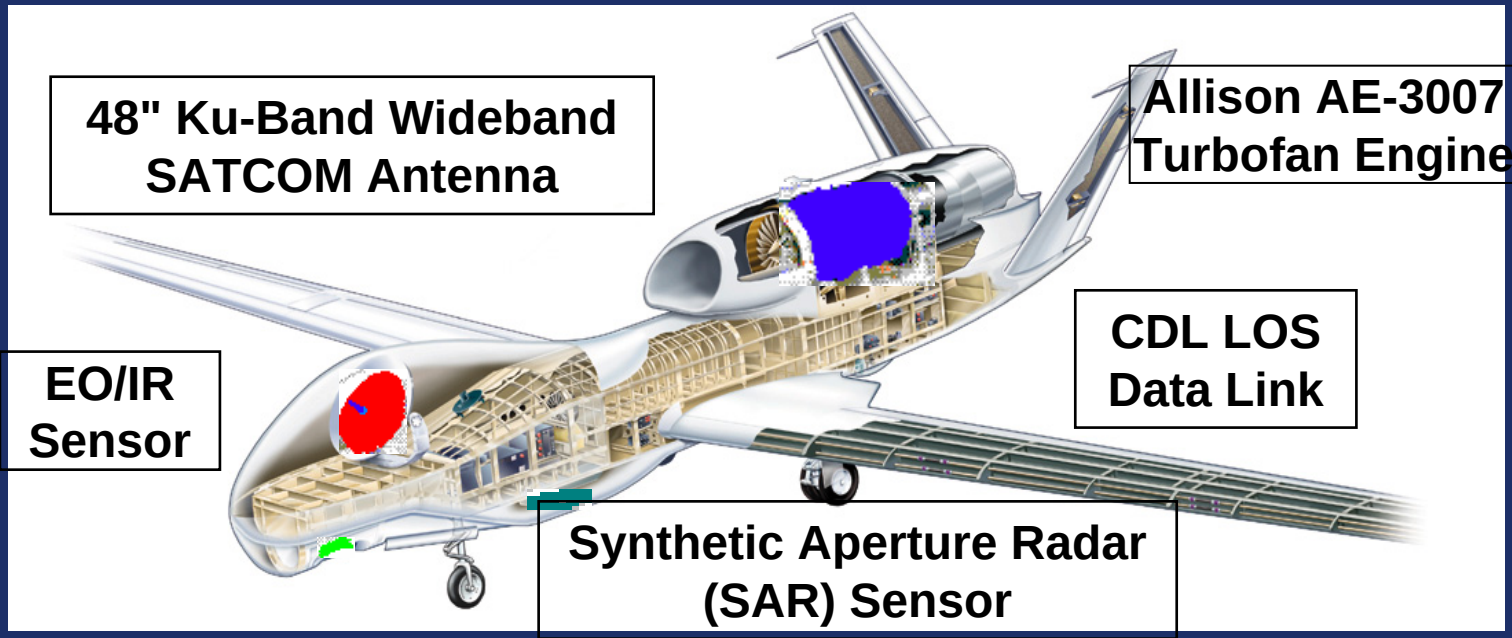


GlobalHawk at NCT

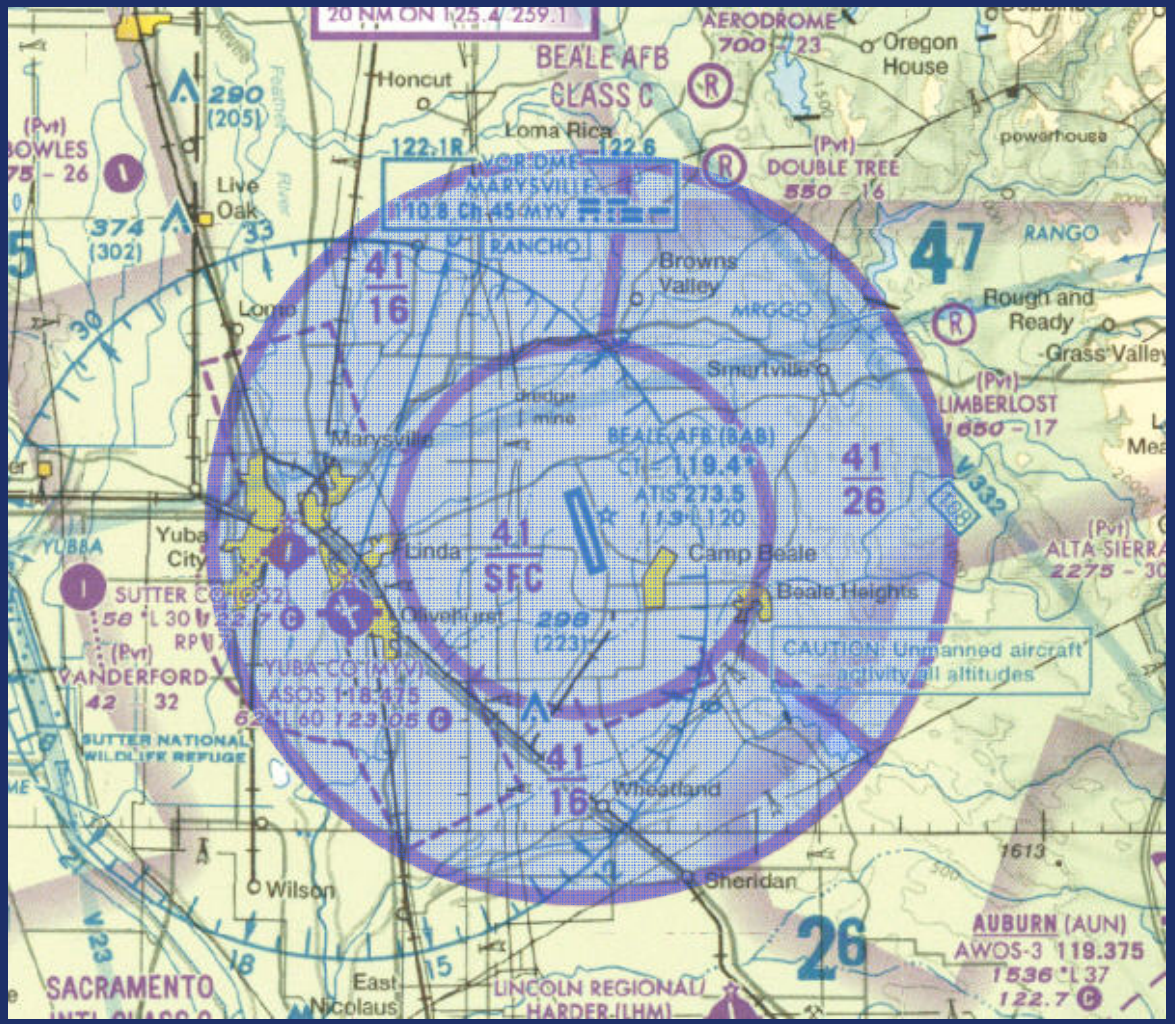
Global Hawk RQ-4A

Performance Goals
- Range: 12,500 nmi
- Endurance: 35 hrs
- Endurance @1200nm: 24 hrs
- Altitude: 65,000 ft
- True Airspeed: 350 kts
- Gross T/O wt: 25,600 lbs
- Payload wt: 2,000 lbs

Specifications
- Wing span: 116 ft
- Length: 44 ft
- Height: 15 ft

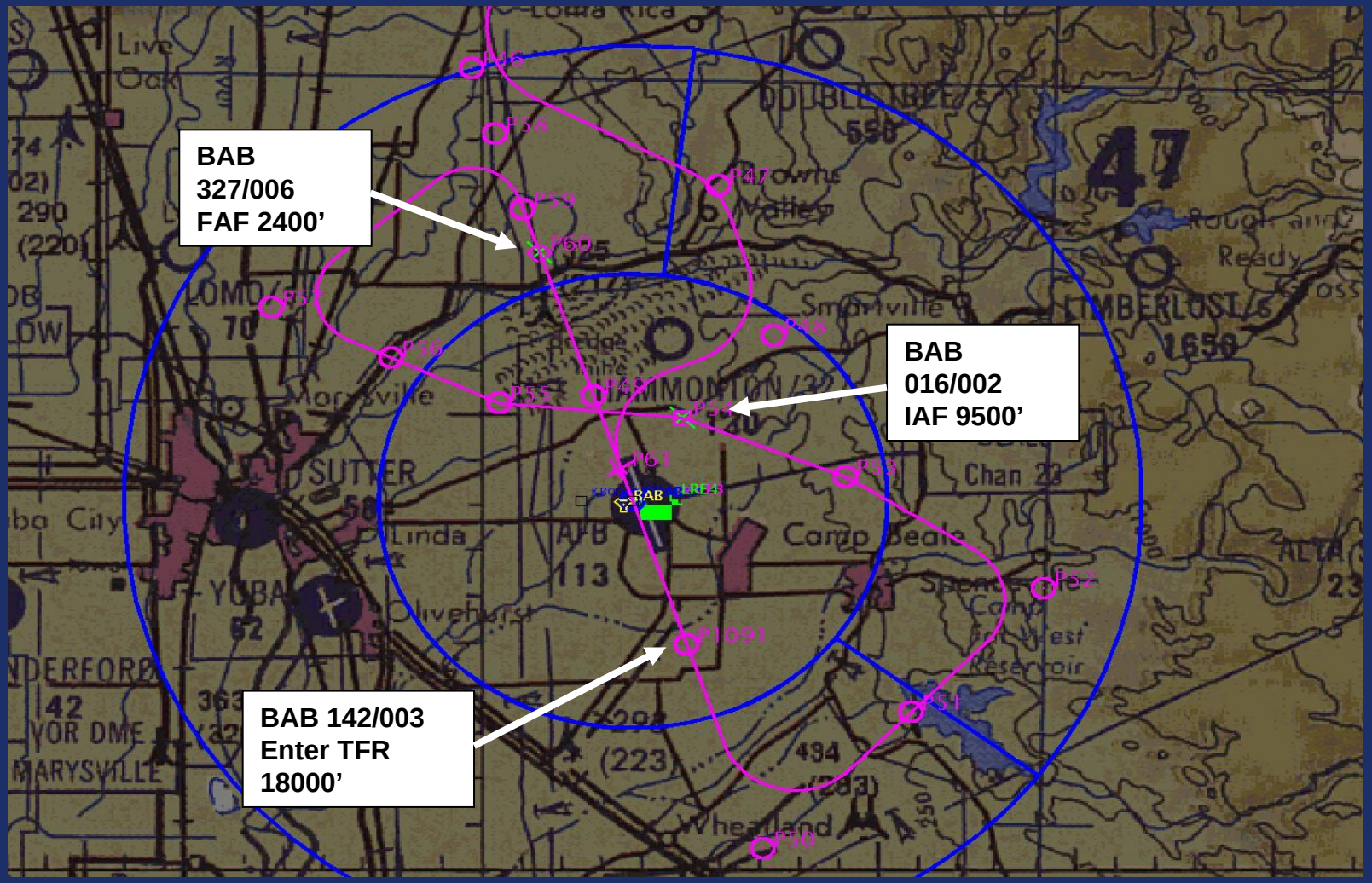


Current TFR Design



TFR Overlies BAB
Class Charlie Airspace
4,100 MSL
Up To And Including
18,000 MSL

Global Hawk Arrival Procedure



Global Hawk Experiences

- **Learning as we go**
  - Actual System Operations
  - Pilot/Controller learning curve
  - Local Pilot Knowledge/Communications
  - TFR on/off switch

NCT airspace is the only place in the NAS where a large Unmanned Aerial System vehicle is operating outside restricted airspace and without a chase plane.

Questions?